

*WHAT MAKES EXTINCTION WORK: AN ANALYSIS OF
PROCEDURAL FORM AND FUNCTION*

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We examined methods for determining how extinction should be applied to different functions of self-injurious behavior (SIB). Assessment data indicated that the head banging of 3 children with developmental disabilities was maintained by different reinforcement contingencies: One subject's SIB was positively reinforced by attention from adults, the 2nd subject's SIB was negatively reinforced by escape from educational tasks, and the 3rd subject's SIB appeared to be automatically reinforced or "self-stimulatory" in nature. Three functional variations of extinction—EXT (attention), EXT (escape), and EXT (sensory)—were evaluated, and each subject was exposed to at least two of these variations in reversal or multiple baseline designs. Reductions in SIB were observed only when implementation of "extinction" involved the discontinuation of reinforcement previously shown to be responsible for maintaining the behavior. These results highlight important differences among treatment techniques based on the same behavioral principle (extinction) when applied to topographically similar but functionally dissimilar responses, and further illustrate the practical implications of a functional analysis of behavior disorders for designing, selecting, and classifying therapeutic interventions.

DESCRIPTORS: extinction, functional analysis, self-injurious behavior

Research on the functional analysis of severe behavior disorders has produced a variety of interventions based on the modification of antecedent events that occasion behavior problems as well as the consequences that maintain them (see Iwata, Vollmer, & Zarcone, 1990, and Mace, Lalli, & Lalli, 1991, for recent reviews). Much of the emphasis in treatment has been on strengthening new stimulus-response-consequence relationships. By contrast, relatively little attention has been paid to eliminating reinforcement that maintained the be-

havior problem in the first place, even though many of the interventions described in the literature implicitly contained such a provision. That is, punishment of Response A is almost always combined with the cessation of reinforcement; likewise, treatment involving reinforcement of Response B as a replacement for Response A usually coincides with the termination of reinforcement for Response A. Moreover, data from several recent studies suggest that the effects of reinforcement-based interventions may be limited unless extinction (withholding the behavior's maintaining reinforcers) is included as part of the treatment program. It has been shown, for example, that interventions based on the development of communicative responses (Carr & Durand, 1985) and on behavioral momentum (Mace & Belfiore, 1990) produced either mixed

This research was supported in part by a grant from the Developmental Disabilities Planning Council and the Florida Department of Health and Rehabilitative Services.

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results (Wacker *et al.*, 1990) or no treatment effect (Zarcone, Iwata, Hughes, & Vollmer, 1993) when implemented without extinction, and that the critical feature of procedures such as differential reinforcement of other behavior (DRO) contingencies appears to be the extinction component rather than the reinforcement component (Mazaleski, Iwata, Vollmer, Zarcone, & Smith, 1993).

The assessment and treatment of self-injurious behavior (SIB) provide an important context for the examination of extinction, because it has been demonstrated that SIB can be maintained through a variety of operant mechanisms. Nevertheless, because the "discontinuation of reinforcement" for behavior problems in general often involves cessation of ongoing events, this procedure has become so common that some textbooks define extinction solely through reference to "ignoring," time-out, and other examples of stimulus termination (e.g., LaVigna & Donnellan, 1986). However, research has shown that procedural time-out can serve different functions, not all of which are behavior reducing (Plummer, Baer, & LeBlanc, 1977; Solnick, Rincover, & Peterson, 1977), and the same is true of procedural approaches to defining extinction. Ignoring misbehavior may represent extinction in some cases but not in others; conversely, the correct application of extinction may require termination of events in some cases but continuation in others. The procedures that define extinction in a given situation are determined by the specific nature of the reinforcement to be "discontinued."

In cases in which SIB was maintained by social-positive reinforcement in the form of adult attention, extinction consisted of withholding attention or terminating it contingent on the occurrence of SIB (e.g., Day, Rea, Schussler, Larsen, & Johnson, 1988; Lovaas & Simmons, 1969). By contrast, SIB maintained through social-negative reinforcement in the form of escape from task demands has been extinguished by preventing escape; in other words, *continuing and not terminating* the ongoing situation (e.g., Iwata, Pace, Kalsher, Cowdery, & Cataldo, 1990; Repp, Felce, & Barton, 1988). Finally, SIB apparently maintained by nonsocial, automatic reinforcement (e.g., sensory stimulation)

has shown extinction-like decreases when the individuals wore equipment that allowed the behavior to occur, but attenuated its consequences (e.g., Rincover & Devany, 1982). Thus, at least three functional variations of extinction have been used as treatment for SIB, each designed to terminate a different source of reinforcement, and each amenable to a number of procedural modifications and descriptive labels.

Although extinction procedures are clearly unique from the standpoint of both form (specific therapist actions) and function (the maintaining contingencies to which they apply), these variations are not well differentiated through existing terminology. *Planned ignoring*, the label perhaps most often applied to extinction of attention-maintained behavior (Nelson & Rutherford, 1983), provides an adequate description of the therapist's response, but it does not describe the underlying behavioral process (extinction), nor does it identify the source of reinforcement being withheld (attention). *Escape extinction*, a term used to describe extinction of escape-maintained behavior (Iwata, Pace, Kalsher, Cowdery, & Cataldo, 1990), specifies the relevant process as well as the reinforcer, but not the procedure. Finally, *sensory extinction*, which refers to a variety of techniques designed to attenuate stimulation directly produced by a response (Rincover, 1978; Rincover, Cook, Peoples, & Packard, 1979), has the same descriptive characteristics as escape extinction (it specifies process and reinforcer, but not procedure); in addition, the wording is awkward because nothing "sensory" is extinguished. In an attempt to promote brevity as well as consistency of terminology, we have adopted throughout this paper the convention of referring to different *functional variations* of extinction by using the abbreviation "EXT" followed in parentheses by the source of reinforcement withheld, as in EXT (attention), EXT (escape), and EXT (sensory). We chose "EXT" (attention) over "attention EXT" because the former places emphasis on behavioral process, with the reinforcer incidental, whereas the latter connotes that attention is extinguished.

This terminology is still incomplete because it does not differentiate *procedural variations* within

a given functional class of extinction techniques. For example, EXT (attention) may take different forms depending on the situational context in which it is applied. If the target behavior occurs in the absence of ongoing social interaction, EXT (attention) requires no response from the therapist and simply consists of withholding attention that previously followed the behavior. A more complicated situation exists if the target behavior occurs while the therapist is interacting with the client. In this case, withholding reinforcement [EXT (attention)] would consist of terminating the interaction.¹ Because similar variations are also characteristic of both EXT (escape) and EXT (sensory), we did not attempt to specify any particular procedure by way of descriptive label; this practice is consistent with terms such as DRO, time-out, punishment, and so forth, all of which require further elaboration.

A reasonable conclusion based on descriptions of behavior, procedure, and outcome reported in the above studies is that extinction designed for SIB serving one function may have little or no therapeutic effect on SIB serving a different function. Given the variations of extinction described previously and the maintaining contingencies for which they might be used, it is possible to construct a contingency matrix such as that found in Figure 1, which allows predictions about behavioral outcome. For example, elimination of social reinforcement for SIB using EXT (attention) or EXT (escape) will not interfere with the delivery of sensory (automatic) reinforcement, and EXT (sensory) would have no effect on social sources of reinforcement. Most seriously, EXT (attention) applied to escape-maintained SIB (i.e., stimulus removal contingent on escape behavior) and, conversely, EXT (escape) applied to attention-maintained SIB (i.e., stimulus continuation contingent on attention-getting behavior) may be countertherapeutic and seriously exacerbate the behavior problem. At the

FUNCTIONAL VARIATIONS OF EXTINCTION

	EXT(Attention)	EXT(Escape)	EXT(Sensory)
Social Sr+ (Attention)	Treatment	Contraindicated	Irrelevant
Social Sr- (Escape)	Contraindicated	Treatment	Irrelevant
Automatic Sr+ (Sensory)	Irrelevant	Irrelevant	Treatment

MAINTAINING CONTINGENCY FOR SIB

Figure 1. Expected outcomes when functional variations of extinction are applied to different maintaining contingencies for SIB.

present time, evidence directly supporting these predictions can be found in only a few studies. Research on the treatment of self-injurious escape behavior, for example, sometimes has included a baseline condition in which time-out from educational tasks was made contingent on SIB (Iwata, Pace, Kalsher, Cowdery, & Cataldo, 1990; Repp et al., 1988; Steege et al., 1990). In effect, this condition procedurally amounted to EXT (attention) but was associated with increases in escape-maintained SIB.

In the present study, we provide an empirical evaluation of the key predictions found in Figure 1 by conducting a comparative analysis of extinction techniques. The relative effects of three functional variations of extinction were examined when applied to the same topography of SIB maintained by three different contingencies of reinforcement.

METHOD

Subjects and Setting

Subjects were selected for participation based on (a) their having similar topographies of SIB, and (b) the outcomes of functional analysis baselines indicating that their SIB was maintained by different sources of reinforcement. Three children with developmental disabilities who met these criteria were included as participants. All of them exhibited head banging that produced contusions or lacerations on the head and face. Donnie, a 7-year-old boy with severe mental retardation, was ambulatory

¹ In this example, it is unclear if the subsequent change in behavior reflects withholding of contingent reinforcement that maintained SIB (extinction) or removal of ongoing reinforcement (time-out). In either case, and from a practical standpoint, the only means of *not* reinforcing the behavior consists of terminating interaction.

and could feed himself. He did not follow vocal instructions, although he had a fairly good imitative repertoire, and he communicated his needs by pointing. Donnie's parents could not identify any situations that were predictive of either high or low levels of SIB. His previous treatments consisted of response interruption, redirection to another activity, time-out, and differential reinforcement. Jack, a 12-year-old boy with severe mental retardation, was nonambulatory but could move his wheelchair over short distances, feed himself, and manipulate small objects. He followed a few instructions and communicated primarily through idiosyncratic gesture (i.e., reaching and making a high-pitched vocal noise). Jack's parents and teachers reported that his SIB seemed to occur as part of a tantrum, although they could not reliably describe the types of situations in which tantrums occurred. His previous treatments consisted of time-out and differential reinforcement. Millie, an 8-year-old girl with moderate mental retardation, was ambulatory, could feed herself, and occasionally followed simple instructions. Although she did not exhibit any expressive language, she appeared to be socially responsive to adults (e.g., she approached adults when they were nearby, smiled at them, etc.). Millie's parents indicated that her SIB occurred "most of the time," but became worse when she did not "get her way." Her previous treatments consisted of verbal reprimands, response interruption, manual restraint, redirection, and differential reinforcement. She was also placed in a hard seizure helmet as a means of protection when her SIB was deemed to be "uncontrollable."

Sessions were usually conducted individually in therapy rooms containing one-way observation windows, but occasionally (due to scheduling necessities) were run in a large group area where two or three other clients and one or two other staff members were present but located in a different part of the room (i.e., at least 6 m away). This periodic change in location seemed to have no effect on the subjects' behavior. Sessions were 15 min in duration and usually were conducted 5 days per week, with four to eight sessions daily and at least 15-min breaks between sessions.

Response Measurement and Reliability

SIB was defined as any audible contact between the head or face and either a fist or an object (e.g., furniture or walls). Data were recorded using one of two methods: (a) on paper during continuous 10-s intervals, which were cued by cassette tape; or (b) on a hand-held computer (Panasonic Model RL-H1800). All data were converted into percentage of 10-s intervals during which one or more instances of SIB occurred. Data were also collected on a variety of experimenter behaviors (delivery of instructions or attention, withdrawal of instructions or attention, placement and removal of apparatus) as a means of monitoring procedural consistency; these data indicated that experimenter compliance exceeded 90% across all categories.

Interobserver agreement was assessed by having a second observer simultaneously but independently record data during 23% of all sessions. Agreement percentages were calculated based on interval-by-interval comparison of observers' records by dividing the number of agreements by the number of agreements plus disagreements and multiplying by 100%. Mean agreement was 92% across subjects, with all values exceeding 86%.

Experimental Designs and Sequence

During the initial baseline, subjects were exposed to a series of assessment conditions in a multielement design (Sidman, 1960; Ulman & Sulzer-Azaroff, 1975) to identify the maintaining variables for their SIB. Subsequently, each subject was exposed to two or more functional variations of extinction by way of reversal or multiple baseline designs. Because the specific conditions and their order of presentation were determined by subjects' baseline performances, more complete details are provided in the Results section for each subject.

Functional Analysis Baseline

Subjects were exposed to four conditions based on Iwata, Dorsey, Slifer, Bauman, and Richman (1982). A brief description of each condition is provided here.

Attention. This condition was designed to test

for positive reinforcement (attention) as a maintaining variable for SIB. An experimenter initially placed the subject in contact with toys that were in the room, then proceeded to ignore the subject while seeming to do paperwork. Contingent on the occurrence of SIB, the experimenter expressed concern (e.g., "Stop. Don't do that; you'll hurt yourself.") and briefly interrupted the response.

Demand. This condition was a test for negative reinforcement (escape from demands) as a maintaining variable. An experimenter presented academic tasks (e.g., object identification, sorting, drawing, and other tasks requiring simple motor responses) comparable to those found in the subject's individual educational plan. Tasks were presented in a discrete-trial format approximately once every 30 s. The experimenter used modeling and physical guidance as supplementary prompts to produce compliance, delivered praise contingent on correct responses, and implemented a 30-s timeout contingent on the occurrence of SIB. The timeout consisted of removing the materials from the table and turning away from the subject.

Alone. By restricting access to social and material sources of stimulation, this condition provided a test for SIB maintained by nonsocial (automatic) reinforcement. The subject was observed while alone in the room (which was empty except for a chair or couch).

Play. This condition served as a control. The experimenter provided continuous access to toys, delivered praise approximately every 30 s contingent on the absence of SIB, and ignored occurrences of SIB.

Extinction Conditions

Three variations of extinction were evaluated, each designed to discontinue a different source of reinforcement for SIB. An attempt was made to implement each type of extinction with each subject, but this was not always possible if (a) little or no SIB occurred in a given baseline condition, or (b) the baseline condition itself was not amenable to implementation of the procedure as described. For example, it was not possible to prevent escape from tasks (i.e., to withhold negative reinforcement)

during the alone baseline, because no tasks were presented initially.

EXT (attention). This variation of extinction was designed to discontinue positive reinforcement in the form of attention delivered by the experimenter. EXT (attention) already was a component of three of the baseline conditions: during the demand condition, attention was withdrawn contingent on SIB; during the alone condition, no adult was present to deliver any attention; and during the play condition, attention was withheld contingent on SIB. Thus, the attention condition was the only baseline on which EXT (attention) could be introduced as a new manipulation. This extinction contingency consisted of having the experimenter ignore (not attend to) SIB, and was combined with experimenter attention for the absence of SIB, which was delivered on a 30-s DRO schedule. Occurrences of SIB reset the DRO interval.

EXT (escape). This variation of extinction discontinued negative reinforcement in the form of escape from tasks. It was implemented during the demand condition, which was the only condition containing a task requirement. During EXT (escape), learning trials continued as during baseline but were not terminated contingent on SIB. Instead, the experimenter physically guided the subject to comply with the instruction and continued the session according to schedule. It has been noted previously (Iwata, Pace, Kalsher, Cowdery, & Cataldo, 1990) that the physical guidance component of this intervention may represent a punishment contingency. However, (a) guidance was the inevitable consequence of noncompliance even during baseline, and (b) behavior change observed following implementation of this procedure in the above study as well as in others (e.g., Goh & Iwata, 1994; Repp et al., 1988) showed either temporary bursting or gradual decreases consistent with extinction processes.

EXT (sensory). This variation of extinction was designed to attenuate the sensory consequences produced by subjects' head banging, and could be implemented across any of the baseline conditions. Each subject was fitted with an oversized helmet (either a seizure or a lacrosse helmet), which was

reinforced with additional padding. During EXT (sensory), the helmet was placed on the subject's head at the beginning of a session and remained in place throughout (subjects never attempted to remove the helmets). An extension of this "non-contingent" helmet condition was implemented for Donnie and is described below.

RESULTS

Donnie

Figure 2 shows the results obtained for Donnie. He exhibited a considerable amount of SIB across all of the baseline conditions, thus permitting a series of manipulations on each baseline. Moderate levels of SIB were observed during the demand, attention, and play conditions (lower three panels), whereas SIB occurred almost continuously during the alone condition (upper panel) containing no access to social stimulation, play materials, or tasks. These data suggested that Donnie's SIB was maintained by factors independent of the social and physical environment and were consistent with behavior reinforced by directly produced, automatic consequences.

On the alone baseline (top panel), EXT (sensory) was implemented in a reversal (ABAB) design, and results showed decreases in SIB associated with the helmet intervention. The final condition on the alone baseline involved two modifications of the EXT (sensory) procedure. First, play materials that Donnie was observed to manipulate during the original play baseline were introduced. Second, the protective helmet was applied only contingent on the occurrence of SIB. As long as SIB did not occur, Donnie was free to play with the toys and move about without wearing the helmet. When SIB occurred, an experimenter, who was in the room but did not interact with Donnie during the session, placed the helmet on Donnie for a 2-min time-out, during which the toys were removed from sight. These procedural modifications were based on results reported by Dorsey, Iwata, Reid, and Davis (1982), who found that it was possible to transfer control of SIB from a noncontingent to a contingent helmet condition. SIB increased initially

when this change was made on the alone baseline, but eventually decreased to a level similar to that observed during the EXT (sensory) conditions.

On the demand baseline (second panel from the top), the introduction of EXT (sensory) was associated with a rapid and large decrease in Donnie's SIB. This reduction occurred in spite of the fact that the original baseline contingency for SIB—EXT (attention) or, alternatively, escape from the task contingent on SIB—remained in effect. Next, EXT (sensory) was removed and EXT (escape) was implemented; this resulted in an increase in SIB to its baseline level. Finally, the contingent helmet procedure was combined with EXT (escape). The experimenter presented learning trials as before and, contingent on SIB, guided Donnie through the task and then placed the helmet on him. The helmet remained on for approximately 2 min (four learning trials). This condition was associated with a decrease in SIB similar to that seen during the previous EXT (sensory) condition.

On the attention baseline (third panel from the top), the introduction of EXT (attention) had no effect on Donnie's SIB. During the next condition, EXT (sensory), SIB decreased even though it produced attention from the experimenter. The final procedure implemented on this baseline consisted of EXT (attention) combined with a 2-min time-out in the helmet contingent on occurrences of SIB, and was associated with a reduction in SIB similar to that seen in the EXT (sensory) condition.

On the play baseline (bottom panel), which contained an EXT (attention) component, no decrease in SIB was observed until EXT (sensory) was introduced. Subsequently, SIB increased temporarily but decreased again when the procedure was changed to a 2-min time-out in the helmet contingent on SIB.

Jack

The initial baseline of Figure 3 shows the results of Jack's assessment. He exhibited little or no SIB except during the demand condition, which contained two distinctive features: the presentation of task demands and a brief time-out from the task contingent on SIB. The time-out component pro-

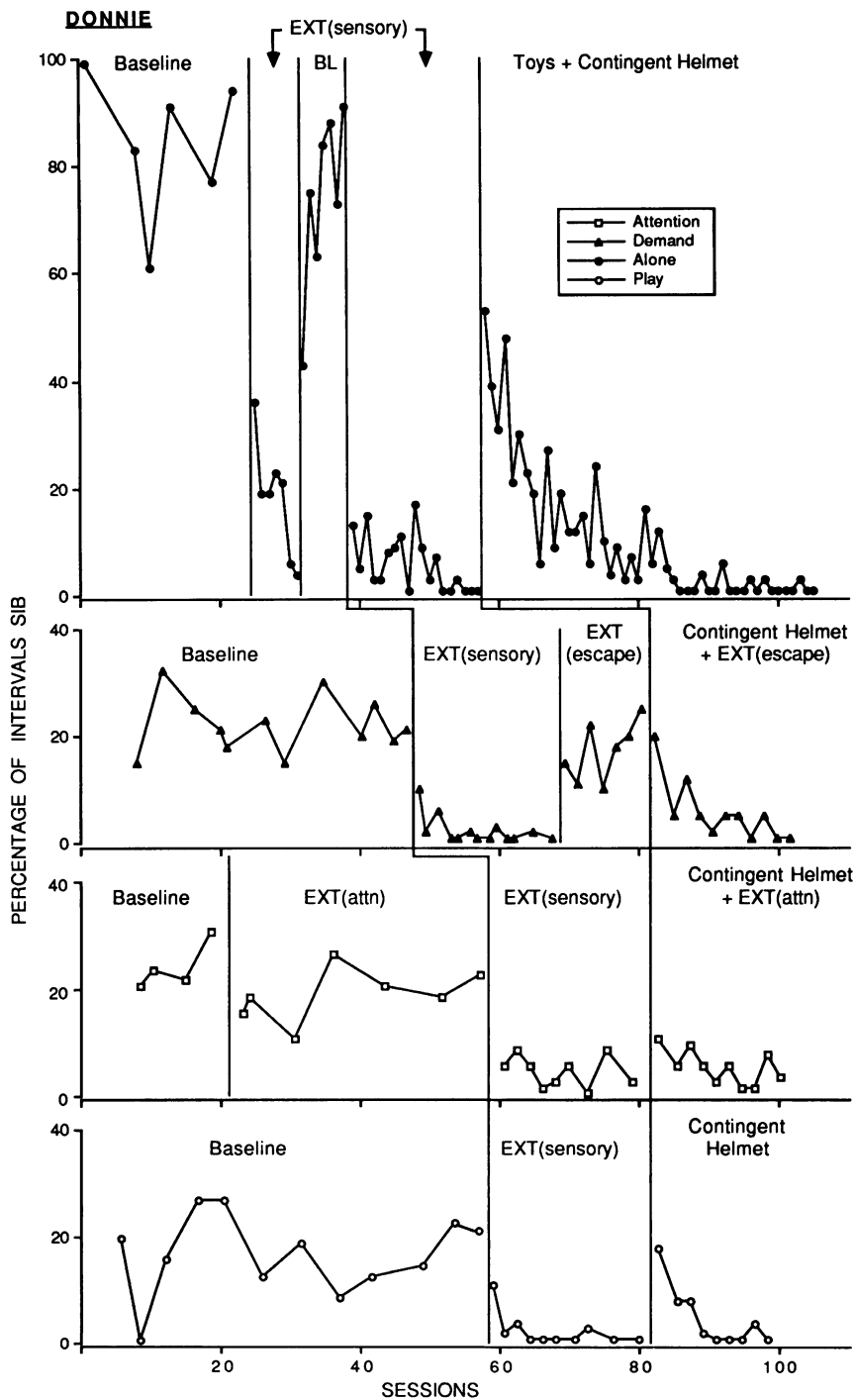


Figure 2. Percentage of intervals of SIB exhibited by Donnie across experimental conditions.

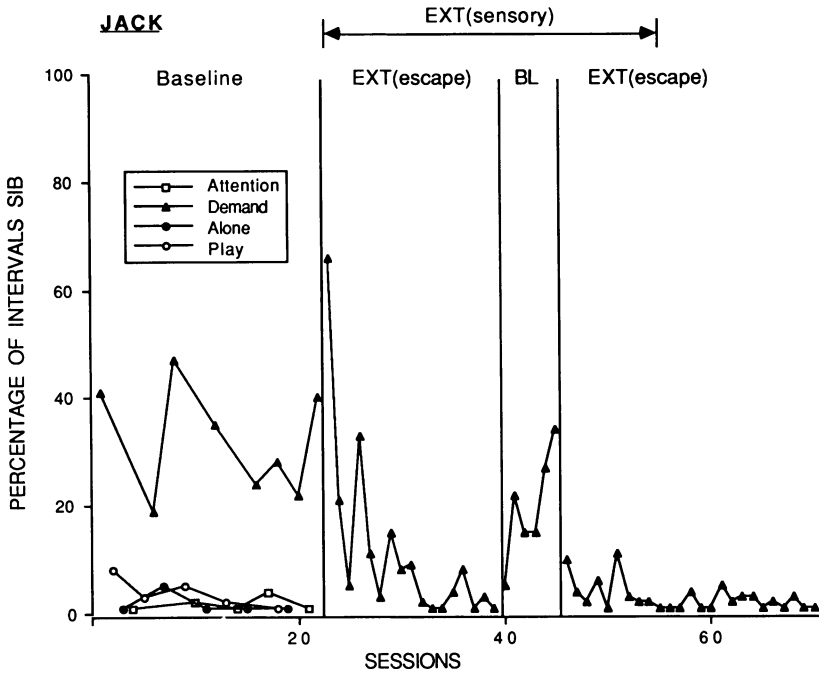


Figure 3. Percentage of intervals of SIB exhibited by Jack across experimental conditions.

cedurally resembled EXT (attention) but appeared to function as (negative) reinforcement for escape behavior. Because little or no SIB was observed during other conditions, all subsequent manipulations were made on the demand baseline. EXT (sensory) and EXT (escape) were implemented concurrently and resulted in a large decrease in Jack's SIB. A partial reversal was then conducted in which EXT (escape) was removed while EXT (sensory) remained in effect; this change resulted in an increase in Jack's SIB to its original baseline level. SIB decreased again when EXT (escape) was reintroduced, and it remained low following the removal of EXT (sensory).

Millie

Figure 4 shows the results obtained for Millie. During the initial baseline assessment, her SIB occurred almost exclusively during the attention condition, suggesting that the behavior was maintained by social-positive reinforcement. Very little SIB was observed during the play and demand conditions, both of which contained a brief time-out from

attention contingent on SIB, and SIB decreased throughout the alone condition, which contained no attention whatsoever. Thus, Millie's assessment data revealed not only a reinforcement effect during the attention condition but also an apparent extinction effect during others.

In light of these results, subsequent interventions were implemented only on the attention baseline. EXT (attention) with attention delivered a 30-s DRO schedule was introduced concurrent with EXT (sensory) and resulted in a large decrease in Millie's SIB. Next, while EXT (sensory) remained in effect, a reversal was conducted in which EXT (attention) + DRO was removed; this partial return to baseline was associated with an immediate and large increase in SIB. When EXT (attention) + DRO was reinstated, SIB decreased to near-zero levels. EXT (sensory) was then removed while EXT (attention) + DRO remained in effect, and no increase was observed in SIB. During this final condition, the length of the DRO interval was gradually increased to 1, 2, and finally 5 min, and SIB remained low across all schedule changes.

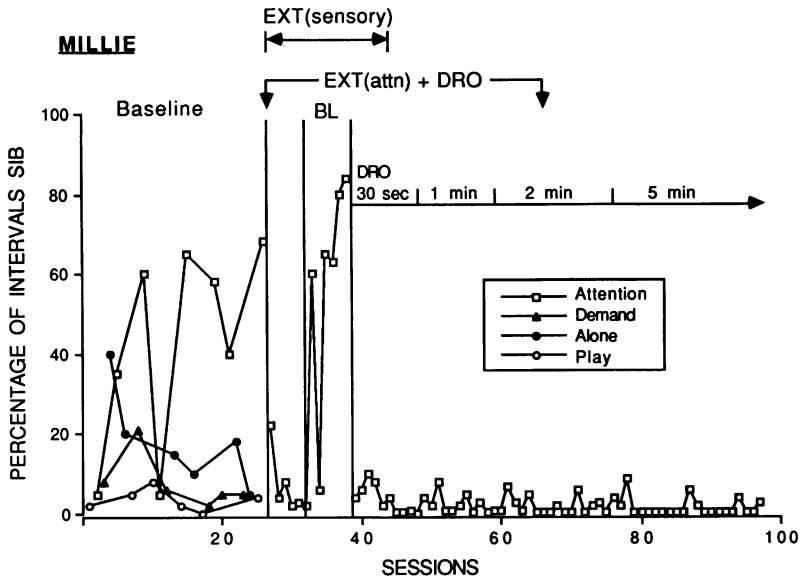


Figure 4. Percentage of intervals of SIB exhibited by Millie across experimental conditions.

Summary of Key Comparisons

Table 1 contains a summary of the results from selected baseline and extinction conditions for Donnie, Jack, and Millie. The data reflect reductions or increases in SIB expressed as mean percentages of baseline responding (EXT mean/baseline mean) for relevant and irrelevant extinction conditions compared to their appropriate baselines. Because SIB during relevant extinction conditions usually showed decreasing trends, comparisons based on overall condition means would not accurately depict

end-of-treatment responding. Therefore, all percentages are based on the last five sessions of a condition. For example, under "Relevant EXT," Donnie's mean percentage of SIB during the last five sessions of EXT (sensory) occurred at 0.5% of the mean SIB during the last five sessions of his alone baseline, whereas under "Irrelevant EXT," his five-session mean percentage of SIB during EXT (escape) occurred at 81.9% of his demand baseline mean. These comparisons show that SIB for all subjects was reduced to below 15% of its baseline

Table 1

Mean Change (Reduction or Increase) in SIB Expressed as a Percentage of Baseline Responding for Relevant and Irrelevant Extinction Conditions Compared to Their Relevant Baselines. Percentages Are Based on the Last Five Sessions of a Condition

Subject	Relevant EXT / baseline		Irrelevant EXT / baseline	
	Conditions compared	% of BL	Conditions compared	% of BL
Donnie	EXT (sensory) / alone BL	0.5	EXT (escape) / demand BL	81.9
	EXT (sensory) / demand BL	6.9	EXT (attn) / attn BL*	81.7
	EXT (sensory) / attn BL*	14.5		
	EXT (sensory) / play BL	8.2		
Jack	EXT (escape) / demand BL	5.4	EXT (sensory) / demand BL	75.8
Millie	EXT (attn) / attn BL	3.6	EXT (sensory) / attn BL	126.3
Mean change as % of baseline SIB		6.5		91.4

* Donnie's attention baseline consisted of only four sessions.

mean during relevant extinction conditions (mean reduction = 6.5% of baseline), but was never reduced to lower than 75% of baseline during irrelevant extinction conditions (mean reduction = 91.4% of baseline).

Follow-Up

At the completion of the study, a treatment program designed for each subject was implemented throughout the day in the appropriate situational contexts. Donnie's program consisted of several components. First, free access to toys was provided whenever possible (except during training sessions, self-care routines, etc.). Second, occurrences of SIB were followed by wearing his padded helmet for 2 min. Finally, and as a preventive measure, the contingent helmet procedure was combined with either EXT (attention) or EXT (escape) depending on the situational context. If Donnie exhibited SIB while participating in training, the session was continued while he wore the helmet. If SIB occurred at other times, the helmet was combined with time-out from social interaction. Jack's treatment consisted of EXT (escape) identical to that described previously, and it was implemented during all training activities. Millie's treatment consisted of attention contingent on appropriate social initiations, defined as any approach behavior while not engaged in SIB. A 5-min DRO contingency also was implemented with attention as the reinforcing consequence. If Millie exhibited SIB while an adult was interacting with her, the adult would turn away and ignore her until (a) Millie approached while not engaging in SIB, or (b) she successfully completed a 5-min DRO interval. Thus, Millie's program contained an explicit EXT (attention) component.

Subjects' parents and teachers were instructed in the use of the above procedures until they demonstrated proficiency in implementation. Follow-up contacts were faded over a 6-month period, during which SIB occurred at well below baseline levels for all subjects.

DISCUSSION

Results of this study showed that therapeutic techniques previously defined as *extinction* in the

applied literature are different not only procedurally but also in their behavioral effects when applied to the same response topography. Each of three variations of extinction—EXT (attention), EXT (escape), and EXT (sensory)—reduced SIB only when it resulted in discontinuation of the specific source of reinforcement maintaining the behavior. Thus, the process of extinction is not tied to any particular form of intervention (e.g., ignoring undesirable behavior); instead, it is determined by the behavior's maintaining contingency. Moreover, the data presented here indicate that if the source of reinforcement for a behavior disorder such as SIB can be identified on a pretreatment basis, much of the guesswork is removed from the task of selecting an appropriate extinction technique.

Results obtained for Donnie provide the most complete analysis in the present study because he was exposed to all three functional variations of extinction. Neither EXT (attention) nor EXT (escape) was effective in reducing Donnie's SIB. His head banging, which apparently was maintained by sensory consequences, was reduced across all baseline conditions when EXT (sensory) was applied, even though SIB still produced attention and escape during the attention and demand baselines, respectively. Jack, for whom EXT (escape) and EXT (sensory) were evaluated explicitly as treatments, was also exposed implicitly to EXT (attention). The brief time-out contingent on SIB during his initial demand baseline closely resembled EXT (attention), yet it actually amounted to negative reinforcement and resulted in the highest levels of SIB when compared to other assessment conditions. EXT (sensory) also had little suppressive effect on Jack's SIB, which decreased only when it no longer produced termination of learning trials during the EXT (escape) condition. For Millie, whose baseline data indicated that her SIB was maintained by positive reinforcement in the form of attention, effective treatment consisted of EXT (attention) combined with DRO (attending to her when she did not exhibit SIB), whereas EXT (sensory) had no apparent effect on her behavior. Millie's results are limited in two respects. First, a stronger demonstration of extinction effects would have been provided had EXT (attention) not been combined

with the DRO procedure, although recent data (Mazaleski et al., 1993) suggest that extinction is the major therapeutic component of DRO contingencies. Second, because little or no SIB was observed during her demand baseline, it was not possible to examine the effects of EXT (escape) on her behavior.

It is important to note that the procedures used in this study, although labeled "EXT" for each subject, differed in two respects. First, because only one variation of extinction was effective in reducing SIB (a different one for each subject), the other two variations did not functionally amount to extinction. We labeled all procedures similarly to reduce confusion and to emphasize the facts that (a) each procedure has been described as an extinction technique in the literature, and (b) procedures so labeled might not produce reductions in behavior if they do not terminate the behavior's maintaining contingency. Based on the results obtained during assessment and treatment, a more accurate description of the procedures used with each subject might be as follows. Donnie was exposed to EXT (sensory), ignoring SIB or terminating interaction contingent on SIB [labeled EXT (attention)], and task continuation and prompting contingent on SIB [labeled EXT (escape)]. Jack was exposed to EXT (escape), a helmet condition [labeled EXT (sensory)], and terminating interaction contingent on SIB (his demand baseline). Millie was exposed to EXT (attention) and a helmet condition [labeled EXT (sensory)]. A second difference can be seen within one of the extinction components. EXT (escape) and EXT (sensory) were applied in a consistent manner during treatment sessions. EXT (attention), however, took two different forms: ignoring SIB that occurred in the absence of interaction, and terminating ongoing interaction contingent on the occurrence of SIB. These differences illustrate a point already noted: Extinction procedures can be defined with respect to both function (the reinforcement contingency being discontinued) and, within function, form (specific therapist actions).

The lack of therapeutic effects observed when a given variation of extinction was applied to SIB maintained by a different (irrelevant) source of reinforcement provides new data on some of the

limiting conditions of extinction. On the other hand, the positive treatment effects observed during relevant extinction conditions were not particularly novel. Previous studies have reported reductions in SIB when the reinforcer withheld during extinction was relevant to behavioral maintenance: EXT (attention) for attention-maintained SIB (e.g., Lovaas & Simmons, 1969), EXT (escape) for escape-maintained SIB (e.g., Iwata, Pace, Kalsher, Cowdery, & Cataldo, 1990), and EXT (sensory) for automatically reinforced or self-stimulatory SIB (e.g., Rincover & Devaney, 1982). Nevertheless, these findings have not given rise to a consistent terminology that distinguishes one type of extinction from another, they have not been adopted by authors of most textbooks on applied behavior analysis (see Cooper, Heron, & Heward, 1987, for a notable exception), and they have not been incorporated into guidelines regulating the use of behavioral interventions (e.g., *Florida HRS Manual 160-4*, 1989).

Extinction is similar to other behavioral processes, such as reinforcement or punishment, from which a number of therapeutic techniques can be derived. Although this fact applies to all behavioral interventions, the case of punishment is of greatest concern because some of its procedural variations are considered to be highly intrusive or otherwise unacceptable (O'Brien & Karsh, 1990). As a result, administrative and treatment manuals place a great deal of emphasis on the topographical aspects of intervention in order to promote procedural consistency by specifying the acceptable limits of therapist behavior when implementing a given technique. Although this approach to treatment classification results in a well-defined system of procedures, behavioral effects may be difficult to predict because therapist behavior, although clearly defined, may enter into multiple contingencies with respect to client behavior. Thus, "planned ignoring" functions as EXT (attention) for attention-seeking behavior but as negative reinforcement for escape behavior, whereas procedures such as "redirection" or other attempts to prompt compliance with task demands function as EXT (escape) for escape behavior but as positive reinforcement for attention-seeking behavior. Functions other than

EXT (sensory) that might be attributed to the helmet intervention used in this study are not entirely clear at the present time, but they might include punishment (wearing the apparatus as an aversive event), social reinforcement (attention paired with equipment placement), or time-out (overall reduced access to reinforcement while wearing the equipment).

Problems may arise when any of these procedures serves unintended functions such as those just described. At best, these discrepancies may result in the use of *ineffective treatments* described as extinction (e.g., as in ignoring automatically reinforced behavior); at worst, they may result in the use of *highly inappropriate treatments* described as extinction (as in ignoring or time-out for escape behavior). In either case, failure to distinguish between the principle of extinction and the ways in which it may be applied can lead to the erroneous conclusion that "extinction" is a relatively ineffective intervention. When these errors are formalized by way of regulation, an unfortunate state of affairs may result: Procedural manuals designed to protect persons from intrusive interventions (e.g., punishment) to reduce behavior may require the use of nonintrusive interventions (e.g., misapplied ignoring or attention) that strengthen dangerous behavior to the point that the intrusive intervention is required.

Although the results of this study are limited to consideration of extinction effects, they have implications for the design of interventions based on other learning mechanisms. For example, behavioral function is highly relevant to the selection of "reinforcers" delivered and withheld in differential reinforcement contingencies (Carr & Durand, 1985), and although social reprimands often have been found to function as punishment, they can also serve as positive reinforcement (Van Houten & Doleys, 1983). Thus, data from a number of studies on the functional analysis of behavior disorders indicate that current methods for classifying interventions are inadequate. There is a critical need to develop classification systems and treatment manuals that specify not only procedures, topographies for which they may be used, and preferred hierarchy

based on consideration of factors such as "intrusiveness," but also how the *same principle* of learning may be translated into *different procedures* based on *differences in behavioral function* (see Iwata, Vollmer, Zarcone, & Rodgers, 1993, and Repp & Karsh, 1990, as examples).

Because the present results indicated that identification of a behavior's maintaining reinforcers was a prerequisite to the appropriate use of extinction (unknown reinforcers cannot be withheld), it appears that an answer to the question "Is a functional analysis of a behavior problem useful in developing an effective treatment program?" can be provided by way of data. This represents a significant improvement over other answers based on theory, logic, or humane philosophy without direct empirical evidence.

But extinction represents only one approach to treatment. There is ample evidence in both the basic and applied literature that punishment can override the effects of reinforcement. However, almost all studies involving the use of punishment to reduce behavior problems contain a limitation noted previously: Administration of punishment is confounded with the termination of reinforcement. Extinction is relevant to a consideration of punishment effects because, from the standpoint of methodology, the suppressive properties of a punishing stimulus should be evaluated while behavior is concurrently reinforced, unless it can be shown first that extinction alone does not reduce behavior. Such an arrangement increases the likelihood that observed reductions in behavior can be attributed to punishment rather than to extinction, which seems to be important as a justification for using punishment over extinction. At the present time, it is unclear that punishment so applied would have the same suppressive effects as those typically reported in the literature. This fact, in addition to the possibility that stimuli delivered as punishment could function as reinforcement, underscores the relevance of both functional analysis procedures and extinction controls to research on punishment.

With respect to reinforcement-based interventions, the finding that arbitrary or irrelevant reinforcers—those that do not maintain the target be-

havior—delivered in a DRO or DRA schedule successfully competed with an intact baseline of reinforcement for the behavior problem (i.e., the target behavior still produced the maintaining reinforcer) argues against the necessity of identifying the maintaining reinforcer. That is, if reinforcers could be found that are different than but substitutable for those maintaining the behavior problem, the task involves merely finding powerful reinforcers. Several studies on DRO as treatment for SIB have shown that reinforcer substitutability can be achieved (e.g., Corte, Wolf, & Locke, 1971; Cowdery, Iwata, & Pace, 1990), but results from other studies indicate that reinforcers irrelevant to behavioral function do not always compete successfully with relevant ones (e.g., Carr & Durand, 1985). Thus, it appears that reinforcer substitutability is possible under conditions that remain to be identified at the present time (see Green & Freed, 1993, for a general review of the topic). Nevertheless, it seems that a search for those conditions should include specification of the maintaining reinforcer for which another stimulus would serve as substitute, and that the evaluation of substitution effects should include an extinction control (see Mazaleski et al., 1993, for an example of this methodology).

Extinction alone is rarely recommended and perhaps accounts for the fact that little research has been conducted on extinction effects per se. In light of the present results indicating that properly designed extinction procedures can produce powerful clinical effects, future research on the treatment of severe behavior disorders should include more careful consideration of extinction as an integral component of intervention as well as a significant source of confounding effects when evaluating both reinforcement- and punishment-based approaches to treatment.

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Received March 12, 1993

Initial editorial decision May 4, 1993

Revisions received July 23, 1993; August 6, 1993

Final acceptance August 26, 1993

Action Editor, F. Charles Mace