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EFFECTS OF REINFORCEMENT FOR ALTERNATIVE BEHAVIOR DURING PUNISHMENT OF SELF-INJURY

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A number of variables influence the effectiveness of punishment and may determine the extent to which less intrusive forms of punishment may be used as alternatives to more intrusive interventions. For example, it has been suggested that response suppression during punishment may be facilitated if reinforcement is concurrently available for an alternative response. However, results of basic research demonstrating this finding have not been replicated with interventions more commonly prescribed as treatments for problem behavior. We evaluated the effects of relatively benign punishment procedures (reprimands or brief manual restraint) on the self-injurious behavior of 4 individuals who had been diagnosed with mental retardation, when access to reinforcement for alternative behavior (manipulation of leisure materials) was and was not available. In all cases, punishment produced greater response suppression when reinforcement for an alternative response was available.

DESCRIPTORS: punishment, reinforcement, self-injurious behavior

The use of punishment has decreased in recent years as a result of movement toward less restrictive treatments for severe problem behavior. For example, Miltenberger (1997) recommended that treatments involving antecedent interventions, extinction, and differential reinforcement should be evaluated prior to the use of punishment. This emphasis on reinforcement-based interventions has been facilitated by the introduction of functional analysis methodology (Iwata, Dorsey, Slifer, Bauman, & Richman, 1982/1994). When the function of problem behavior can be identified, a number of reinforcement-based treatments that directly address maintaining variables, such as functional communication training (Carr & Durand, 1985) or noncontingent reinforcement (Vollmer, Iwata, Zarcone, Smith, & Mazaleski, 1993), may be developed.

In spite of the increased use of functional analysis to aid in the identification of effective interventions, some circumstances may limit the practicality or the effectiveness of reinforcement-based interventions (Vollmer & Iwata, 1993). For example, treatment implementation may be difficult in most service settings if very dense schedules of reinforcement are required to produce clinically significant decreases in problem behavior. In other cases, reinforcement-based interventions may be ineffective without the use of extinction or punishment (Hagopian, Fisher, Sullivan, Acquisto, & LeBlanc, 1998). Finally, it may be difficult to identify stimuli that compete with reinforcement for problem behavior if the reinforcers that maintain problem behavior cannot be identified. Problems such as these may justify, if not necessitate, the use of punishment. For example, in a large-scale evaluation of functional communication training (FCT), Hagopian et al. found that FCT was much more effective when it was combined with punishment. Vollmer, Marcus, and LeBlanc (1994) evaluated the effects of access to preferred stimuli as treatment for 3 individuals following inconclusive functional analyses of their self-injurious behavior (SIB). Large de-

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creases in SIB were observed for 2 participants; however, the addition of a time-out procedure was required for the 3rd participant.

The effects of punishment, like those of reinforcement, may be influenced by a number of variables, one of which is the availability of reinforcement for an alternative response during punishment (Azrin & Holz, 1966). In a study by Holz, Azrin, and Ayllon (1963), time-out was used to decrease knob pulling by 4 psychiatric patients that was maintained by access to cigarettes. Results indicated that time-out was more effective in reducing the target response when reinforcement was available for another response (i.e., button pushing). For 2 of the 4 patients, time-out was ineffective when used alone but resulted in near-zero levels of responding when used in combination with reinforcement for an alternative response. Based on these results, Holz et al. concluded that problem behavior might be decreased most effectively with punishment when another response is available that produces reinforcement. They also suggested that reinforcement of an alternative response may allow clinicians to achieve large decreases in behavior with relatively mild punishment procedures.

The Holz et al. (1963) study has served as an important guiding influence in applied research, although the generality of its findings has not been well established using procedures more commonly prescribed as treatment for behavior problems. Because punishment is rarely used in the absence of reinforcement, applied research on punishment has focused almost exclusively on either (a) the combined effects of punishment and reinforcement or (b) the additive effects of punishment when reinforcement (usually combined with extinction) alone failed to produce therapeutic behavior change. In the few studies in which punishment was examined as the sole independent variable (e.g., Dorsey, Iwata, Ong, & McSween, 1980; Jordan, Singh, & Repp, 1989; Sajwaj, Libet, & Agras, 1974), the additive effects of reinforcement were not evaluated. Thus, the extent to which reinforcement enhances the effects of punishment remains largely an unexplored issue in applied behavior analysis.

The purpose of this study was to extend the results of Holz et al. (1963) through systematic replication with commonly used punishment procedures. Two additional features of the Holz et al. study were somewhat uncharacteristic of the typical applied situation. First, punishment was delivered on a fixed-ratio (FR) 10 schedule, whereas in clinical practice punishment is usually applied on continuous (FR 1) schedules. Second, the two responses available in the experimental condition were topographically similar (button pushing, knob pulling) and produced identical forms of reinforcement (cigarettes). It is unknown whether the same results would be obtained if either the topographies or the sources of reinforcement for the punished and reinforced responses had been different (e.g., self-injury [punished response] maintained by one contingency and object manipulation [reinforced response] maintained by another contingency). We evaluated both the separate and combined effects of continuous reinforcement and punishment during four conditions: no treatment, reinforcement alone, punishment alone, and a treatment that involved both reinforcement and punishment. This allowed us to assess the relative contribution of each treatment component to the overall effectiveness of the intervention.

METHOD

Participants and Setting

Four individuals who lived at a state residential facility for persons with developmental disabilities participated. All had been diagnosed with profound mental retardation

and had been referred to a day-treatment program for treatment of SIB. Shelly was a 28-year-old woman who followed simple instructions and communicated through gestures. Her SIB consisted of expelling saliva and then rubbing it onto her hands or other surfaces (e.g., tables, windows), which resulted in frequent tissue damage and infections. Previous interventions included reinforcement for hand drying, noncontingent reinforcement, and mechanical restraint. Ricky was a 34-year-old man who was blind and deaf. He required physical assistance with most activities and did not have any recognizable communication skills. His SIB consisted of head and body hitting that resulted in bruises and contusions. Previous treatments included reinforcement of appropriate behavior (object manipulation), response blocking, and protective equipment. Donna was a 43-year-old woman who followed simple instructions and communicated with gestures. Her SIB consisted of hand mouthing that resulted in frequent tissue damage. Previous interventions included reinforcement of appropriate behavior (object manipulation), differential reinforcement of other behavior (DRO), the use of protective gloves and restraint sleeves, and punishment involving aversive taste. Lynn was a nonambulatory 44-year-old woman with Down syndrome. She required assistance with all activities of daily living and communicated using simple gestures. Her SIB consisted of head hitting that produced bruises; her previous treatments included response blocking and protective equipment.

All sessions were conducted in various rooms at the day-treatment center. Sessions lasted for 10 min and were conducted two to six times per day, 4 to 5 days per week, as individual schedules permitted.

Experimental Sequence

We first conducted a functional analysis to identify variables responsible for the maintenance of each participant's SIB. Results of this analysis indicated that, in all cases, SIB was not maintained by social reinforcement (see below). We then conducted two additional assessments to identify (a) leisure items whose manipulation might produce reinforcement that competed with SIB, and (b) relatively benign punishment procedures that might suppress SIB. Finally, we evaluated both the separate and combined effects of access to reinforcement and punishment.

Response Measurement and Reliability

SIB was defined as follows: any expulsion of saliva (Shelly); head or body hitting, and banging legs or elbows against hard surfaces (Ricky); any contact between hands and either tongue or lips (Donna); and forceful contact between hand and head (Lynn). Object manipulation was defined as any contact between the participant's hands and the designated leisure materials (Shelly, Donna, and Lynn). Object manipulation for Ricky was defined as at least 2 s of unprompted contact with the items (object manipulation was not scored while the therapist delivered physical prompts). Punishment was defined as implementation of the procedures described below.

Trained observers used handheld computers (Assistant Model AST 102) that audibly signaled 10-s intervals to collect data on SIB, object manipulation, and the delivery of punishment. SIB and punishment were recorded as frequency measures; object manipulation was scored as occurrence or nonoccurrence during an interval and was summarized as the percentage of intervals during which responding occurred. The exception to this was Donna's hand mouthing, which was recorded as an interval measure because its duration varied considerably.

Interobserver agreement was assessed by having a second observer simultaneously but independently record data during a mini-

mum of 30% of all sessions. Agreement percentages were calculated on an interval-by-interval basis. For frequency measures, the smaller number of responses in each interval was divided by the larger number of responses; these fractions were then averaged across the intervals and multiplied by 100%. For interval measures, percentage agreement between the two observers was calculated by dividing the number of agreement intervals by the total number of intervals and multiplying by 100%. During the functional analyses, mean percentage agreement across all participants was 91.1% (range, 88.7% to 96.0%) for SIB. During baseline and treatment conditions, mean percentage agreement across all participants was 93.5% (range, 84.3% to 99.2%) for SIB, 92.4% (range, 86.3% to 97.2%) for object manipulation, and 96.8% (range, 93.9% to 98.5%) for implementation of punishment procedures.

Functional Analyses

Participants were exposed to four assessment conditions (demand, attention, play, and alone), which were alternated in a multielement design (see Iwata et al., 1982/1994, for greater detail). During the demand condition, a therapist presented instructional trials and implemented a brief time-out following occurrences of SIB. During the attention condition, the therapist ignored the participant except to deliver brief attention following occurrences of SIB. During the play condition, the participant had free access to leisure materials throughout the session, and the therapist delivered attention on a fixed-time 30-s schedule. During the alone condition, the participant had access to no materials, and no interactions occurred during the session.

Mean levels of SIB for each condition and participant are presented in Table 1. Shelly, Ricky, and Lynn displayed the highest levels of SIB in the alone condition. Donna displayed high levels of SIB in all conditions, including the alone condition. These results indicate that participants' SIB was not maintained by social reinforcement (attention or escape) and are consistent with those from a number of other studies suggesting that SIB was maintained by reinforcement directly (automatically) produced by the response (see Shore & Iwata, 1999, for further discussion).

Table 1
Mean Levels of SIB Across Functional Analysis Conditions

Condition	Shelly	Ricky	Donna	Lynn
Alone	1.8	38.4	87.2	8.5
Attention	0.2	14.7	83.8	6.1
Demand	0.2	25.9	90.7	2.0
Play	0.5	13.7	90.7	2.5

Note. Data are expressed as responses per minute for Shelly, Ricky, and Lynn, and as percentage of intervals for Donna.

Reinforcer Assessments

Following the functional analyses, preference assessments were conducted with each individual. Because Shelly, Donna, and Lynn were observed to manipulate at least a few leisure materials appropriately, the purpose of their assessments was to identify highly preferred leisure items. Seven items were presented individually during 5-min trials, three times each, for a total of 21 trials (see DeLeon, Iwata, Conners, & Wallace, 1999, for further details). During these trials, observers recorded the duration of item manipulation and the frequency of SIB. The three items associated with the highest levels of manipulation and lowest levels of SIB were chosen for use in the study. A Connect 4® game, a Lite Brite®, and wooden stringing beads were selected for Shelly. A Connect 4® game, a string of plastic beads, and a small box of potpourri were selected for Donna. A mirrored microswitch that produced vibration and music, a balloon, and a rubber worm were selected for Lynn. Ricky was

never observed to independently manipulate leisure materials; therefore, his preference assessment was limited to edible items, which were presented individually across repeated trials (see Pace, Ivancic, Edwards, Iwata, & Page, 1985, for further details). M&M® candies were approached during the highest percentage of trials and were therefore selected for use as reinforcers during training trials designed to increase object manipulation.

Punisher Assessments

Next, we conducted brief evaluations to identify an effective punishment procedure for each participant. Procedures were chosen for evaluation based on topographies of SIB, an apparent degree of minimal intrusiveness, and the ability of the experimenter to safely and efficiently implement the procedure. During this phase, we used brief AB designs to evaluate several procedures, and chose the least restrictive procedure that resulted in a 75% or greater decrease in SIB. For example, we initially evaluated a 15-s manual restraint with Shelly. During this procedure, the therapist delivered a verbal reprimand, held Shelly's hands in her lap for 15 s, and then dried her hands with a cloth. This procedure reduced SIB to the criterion level. Subsequently, however, we observed a comparable decrease in SIB when the therapist simply delivered a reprimand (e.g., "no spitting") and dried Shelly's hands (without holding her hands in her lap). Therefore, we chose to implement the reprimand and hand-drying procedure. Using similar assessments with the other participants, we observed that variations of the manual restraint procedure were effective in decreasing Ricky's SIB (hands held in lap for 15 s) as well as Donna's and Lynn's (arms folded in front of chest and held in place for 15 s).

Experimental Design

The effects of punishment were evaluated in a reversal design for Shelly and in a multiple baseline across subjects design for Ricky, Donna, and Lynn. During baseline (ignore) as well as treatment (punishment) phases, participants also were exposed to reinforcement (S^{R+}) and no-reinforcement (no S^{R+}) conditions, which were alternated in multielement designs.

No-punishment (baseline) condition. Throughout this condition, the participant was seated in a chair. The therapist was present in the room but delivered no consequences following occurrences of SIB.

Punishment condition. This condition was similar to the ignore condition, except that each occurrence of SIB was followed by consequences identified during the punisher assessments. Each time Shelly expelled saliva, the therapist delivered a reprimand ("no spitting") and briefly dried each of her hands (and any other wet surfaces) with a cloth. Ricky's hands were held in his lap for 15 s each time he engaged in SIB. Donna and Lynn both received a verbal reprimand and had their hands held across their chests for 15 s following SIB. The session clock was stopped during the implementation of these procedures.

No-reinforcement (no S^{R+}) condition. Throughout this condition, the participant had no access to any leisure materials.

Reinforcement (S^{R+}) condition. Activities identified during the reinforcer assessments were available to participants throughout this condition. Because Shelly, Donna, and Lynn engaged in high levels of appropriate object manipulation with certain leisure materials, we assumed that object manipulation produced its own (automatic) reinforcement. Therefore, preferred leisure materials were simply made available on a noncontingent basis, and no additional reinforcers were delivered. For example, in Shelly's S^{R+} sessions, a Connect 4®, Lite Brite®, and stringing beads were placed on the table at which she was seated. Because we were unable to identify any leisure materials that Ricky would

manipulate independently, we provided edible reinforcement (M&M® candies) for appropriate object manipulation. Due to Ricky's visual impairment, steps were taken to increase the likelihood that he would engage in object manipulation. First, to decrease the effort involved in object manipulation, several items that provided tactile or olfactory stimulation (e.g., a Koosh® ball, beads, craft fur, a box of potpourri) were attached to a vest that Ricky wore during S^{R+} sessions. Second, if Ricky held an object for 2 s, the therapist delivered edible reinforcement (and continued to deliver reinforcement for each 2 s of object manipulation thereafter). Finally, if 10 s elapsed with no object manipulation, the therapist prompted Ricky to touch one of the objects.

RESULTS

Figure 1 shows results obtained for all participants across the four conditions. During the first no-punishment phase, Shelly engaged in moderate rates of SIB (M = 1.0 responses per minute) in the no S^{R+} condition, and lower rates (M = 0.2 responses per minute) in the S^{R+} condition. When punishment was introduced, Shelly's SIB decreased to a mean of 0.3 responses per minute in the no S^{R+} condition and to 0.1 responses per minute in the S^{R+} condition. When punishment was withdrawn, rates of SIB increased in both the no S^{R+} (M = 1.0 responses per minute) and S^{R+} (M = 0.5 responses per minute) conditions. In the final punishment phase, SIB decreased to a mean of 0.3 responses per minute in the no S^{R+} condition and to 0.1 responses per minute in the S^{R+} condition. To summarize, access to reinforcement alone was associated with a decrease in SIB during the initial no-punishment phase, but this effect was less apparent in the second phase. Punishment resulted in large decreases in SIB in both the no S^{R+} and S^{R+} conditions. However, when punishment was used, rates of SIB were somewhat lower in the S^{R+} condition than in the no S^{R+} condition.

Ricky displayed high rates of SIB during both the no S^{R+} (M = 24.7 responses per minute) and the S^{R+} (M = 15.5 responses per minute) conditions of the no-punishment phase. When punishment was introduced, a decrease in SIB was observed in the S^{R+} condition (M = 2.1 responses per minute). A similar decrease occurred during the first three sessions of the no S^{R+} condition; however, this effect was not maintained. SIB increased in the no S^{R+} condition to a mean of 12.6 responses per minute. In addition, Ricky began to resist the hands-down procedure, such that several sessions were terminated early due to the therapist's inability to implement the intervention safely. The punishment with no S^{R+} condition was therefore terminated after seven sessions, and the punishment with S^{R+} condition continued for an additional six sessions. Thus, reinforcement alone did not produce substantial reductions in Ricky's SIB; however, punishment was effective only when combined with reinforcement.

Donna displayed high levels of SIB during both the no S^{R+} (M = 85.3% of 10-s intervals) and S^{R+} (M = 79.1%) conditions in the no-punishment phase. Punishment resulted in gradual decreases in SIB in both the no S^{R+} (M = 33.1%) and S^{R+} (M = 19.9%) conditions. During the last half of the punishment phase, levels of SIB were generally low but were somewhat lower in the S^{R+} condition than in the no S^{R+} condition. Reinforcement alone did not result in a decrease in Donna's SIB during the no-punishment phase; however, punishment produced greater suppression of SIB when it was combined with reinforcement.

Lynn displayed variable rates of SIB during both the no S^{R+} (M = 9.3 responses per minute) and S^{R+} (M = 8.6) conditions during the no-punishment phase. When pun-

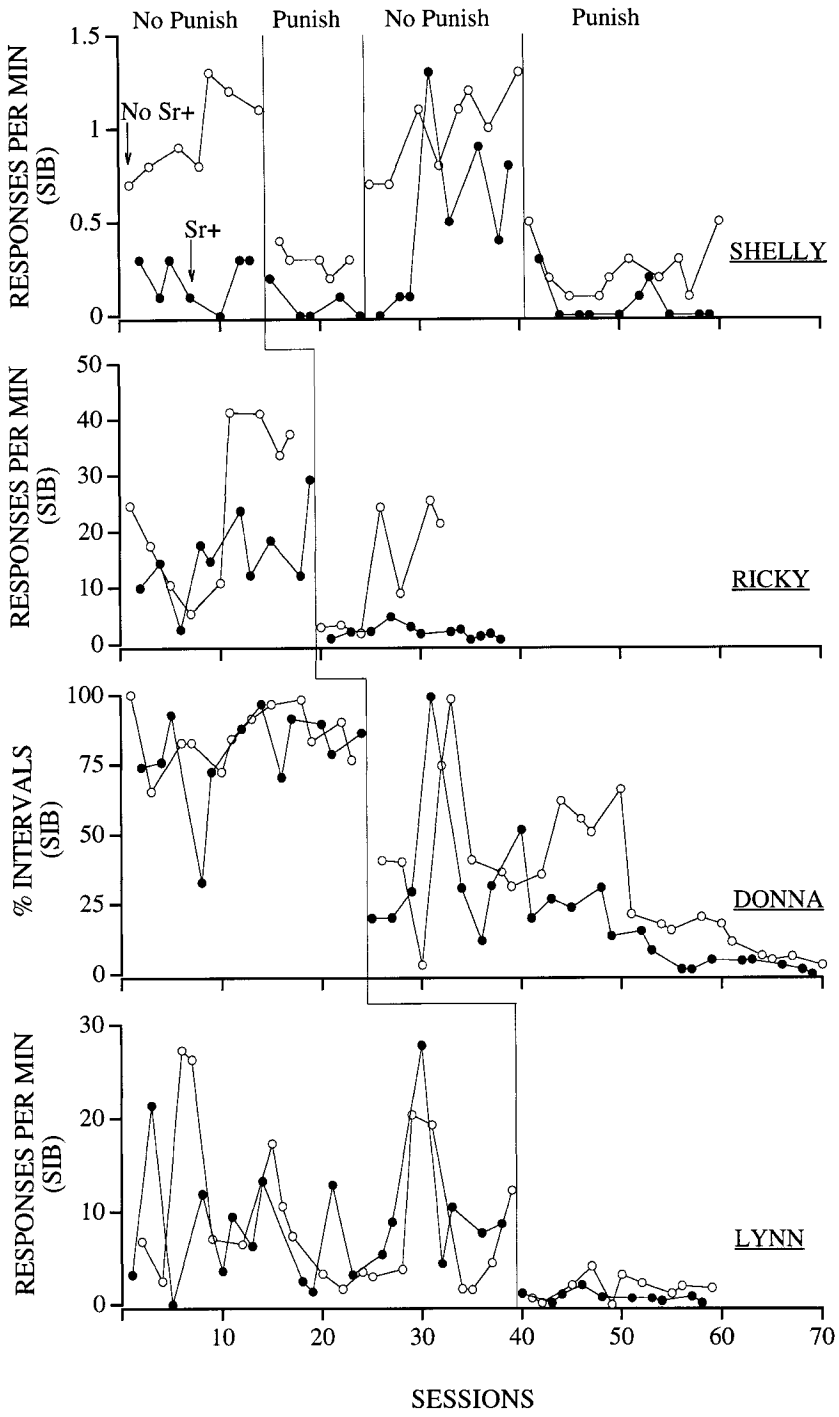

Figure 1. SIB during alternating S^{R+} and no S^{R+} conditions across no-punishment and punishment phases. Note that different *y*-axis scales are used for each participant.

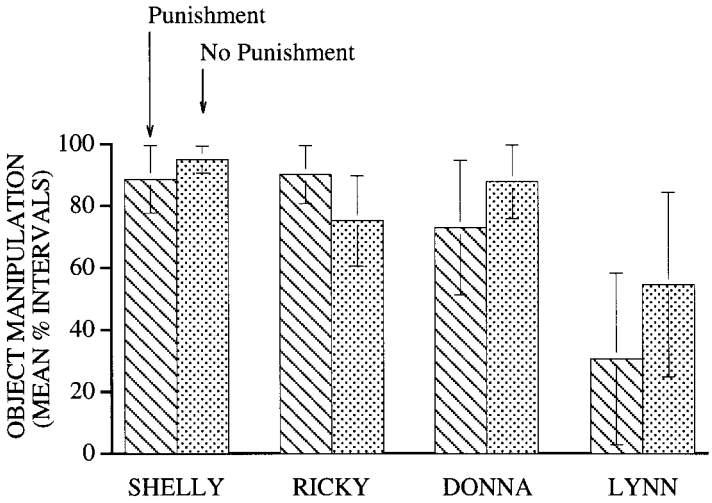

Figure 2. Mean percentage of intervals containing object manipulation (S^{R+} condition) during no-punishment and punishment phases.

ishment was introduced, SIB decreased immediately in both the no S^{R+} ($M = 1.8$) and S^{R+} ($M = 0.8$) conditions, with rates of SIB slightly lower during the S^{R+} condition. Reinforcement alone did not result in a decrease in Lynn's SIB, and it enhanced the effects of punishment only to a slight degree.

Although access to reinforcement (leisure materials) alone produced noticeable reductions only in Shelly's SIB (Figure 1), all participants engaged in moderate to high levels of object manipulation when leisure materials were available. Figure 2 shows data on object manipulation during the punishment and no-punishment conditions, expressed as mean percentages of intervals per session. Shelly, Donna, and Lynn engaged in more object manipulation when punishment was absent, whereas Ricky engaged in more object manipulation when punishment was present.

Figure 3 shows mean frequencies of punishment per session during the S^{R+} and no S^{R+} conditions. All participants received

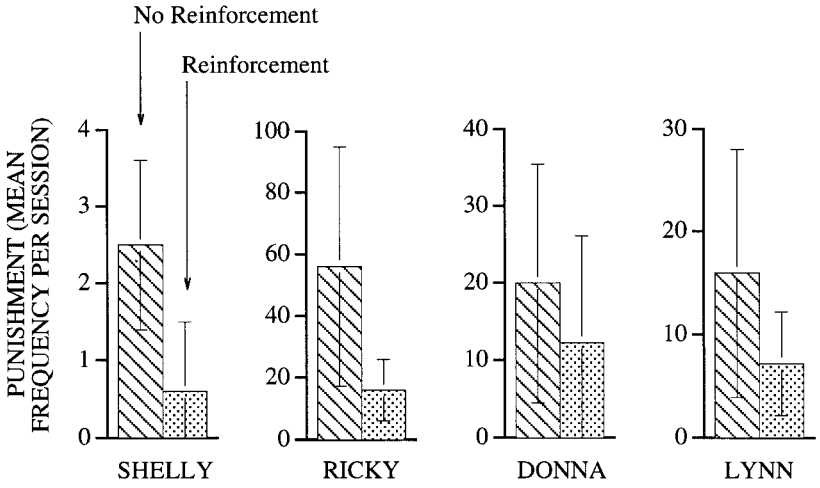

Figure 3. Mean frequency of punishment during S^{R+} and no S^{R+} conditions.

fewer punishments when reinforcement (access to leisure materials) was available. The largest discrepancy can be seen in Ricky's data. He experienced an average of 16 punishments per session in the S^{R+} condition, compared to 56.1 punishments per session in the no S^{R+} condition. It should be noted that the frequency of punishment in the no S^{R+} condition would have been higher had all sessions lasted 10 min.

DISCUSSION

We evaluated the effects of punishment delivered in the presence and absence of reinforcement for an alternative response. To assess the individual and combined effects of both interventions, we examined behavior under conditions of no treatment, reinforcement only, punishment only, and a treatment involving both reinforcement and punishment. Reinforcement alone did not result in large decreases in SIB for any of the participants (the initial decrease in Shelly's SIB during the first S^{R+} [no-punishment] condition was not replicated when the procedure was implemented an second time). Punishment alone resulted in noticeable decreases in SIB for 3 of the participants. Immediate decreases in SIB were observed when punishment was implemented with Shelly and Lynn, and a more gradual decrease was observed with Donna. Ricky's SIB decreased initially during the punishment (no S^{R+}) condition but increased after several sessions. For all participants, punishment was more effective when combined with reinforcement. Greater (Shelly and Lynn) or more immediate (Donna) reductions in SIB were observed when punishment was combined with reinforcement than when punishment was used alone. For Ricky, punishment appeared to be effective only when it was combined with reinforcement.

In some cases, relatively small differences were observed between conditions in which punishment was used alone and those in which punishment was combined with reinforcement. However, these small differences may be clinically important for several reasons. Data on the frequency of punishment indicated that substantially less punishment was delivered when reinforcement for alternative behavior was concurrently available. For example, Lynn received a mean of 16 punishments per session in the no S^{R+} condition compared with a mean of 7.2 per session in the S^{R+} condition. In addition to providing participants with a less restrictive environment, the use of reinforcement also resulted in a decrease in the effort required by staff to implement the procedure. In Lynn's case, the addition of reinforcement resulted in a 55% decrease in the number of punishment procedures implemented by the therapist and only required the therapist to present the leisure items once at the beginning of session.

Levels of object manipulation were slightly lower in the punishment phase relative to the no-punishment phase for Shelly, Donna, and Lynn (Ricky's level of object manipulation increased with the introduction of punishment). It is difficult to account for these results because the study was not designed to directly evaluate the effects of punishment on appropriate behavior. However, it is possible that punishment produced a slight decrease in object manipulation because the delivery of punishment temporarily interrupted (or delayed the onset of) object manipulation. To prevent this potential problem, it maybe beneficial to prompt the alternative behavior frequently when using punishment.

Our general findings were consistent with those reported by Holz et al. (1963), who observed that time-out from reinforcement was more effective in reducing one response when another response produced the same reinforcer. However, there are a few differ-

ences between the procedures used in the present study and those used by Holz et al. that should be noted. Holz et al. provided reinforcement (i.e., cigarettes) contingent upon a specific alternative response (i.e., button pushing), whereas for 3 participants in this study, preferred materials were available noncontingently. Although preferred items were not presented contingently for these participants, some appropriate response (i.e., object manipulation) was presumably required for these individuals to obtain the reinforcement associated with the preferred items. In addition, Holz et al. demonstrated the reinforcing effects of stimuli used to increase the alternative response. In the present study, preference assessments (DeLeon et al., 1999; Pace et al., 1985) were used to identify preferred edible or leisure items, and the reinforcing effects of these stimuli were not specifically evaluated.

There are several reasons why punishment may be more effective when combined with reinforcement for an alternative response. First, the availability of an alternative source of reinforcement may alter the establishing operation for problem behavior. For example, Azrin and Holz (1966) reported that, when punishment is used to reduce responding maintained by food, levels of food deprivation can greatly affect the results. The results of functional analyses for all participants in this study suggested that their SIB was not maintained by social reinforcement. Three of the 4 participants (Shelly, Ricky, and Lynn) engaged in the highest levels of SIB in the alone condition of the functional analysis, indicating that the behavior was most likely to occur when they were deprived of environmental stimulation. For these individuals, it is possible that SIB was maintained by automatic reinforcement (e.g., tactile stimulation). Therefore, access to leisure materials or edible reinforcement may have simply provided an alternative form of stimulation, thereby decreasing motivation to produce the automatic reinforcement available from SIB.

A second reason that reinforcement may have enhanced the effects of punishment is that the availability of an alternative source of reinforcement increased the cost associated with SIB. Access to reinforcement was discontinued while punishment was being delivered (i.e., the leisure materials were removed). Thus, when programmed reinforcement was available in the session, SIB resulted in both the delivery of the punishment procedure and a brief time-out from reinforcement. The addition of this brief time-out may have contributed to the increased effectiveness of the treatment.

Consistent with the recommendations made by Azrin and Holz (1966), results of this study indicate that the effects of punishment can be enhanced when reinforcement is provided for an alternative response. Further, these results suggest a method for increasing the effectiveness of punishment through means other than increasing the aversiveness of the punishing stimulus, thereby resulting in the development of more effective yet less restrictive interventions. However, we must note that the identification of reinforcers for and the subsequent shaping of alternative responses in individuals who have profound developmental disabilities may represent an extremely difficult undertaking (Ivancic & Bailey, 1996). Thus, results of this study highlight the need for a continued focus in research and clinical practice on procedures for increasing appropriate behavior in individuals with severe problem behavior.

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STUDY QUESTIONS

1. What are some circumstances that may limit either the effectiveness or practicality of reinforcement-based treatments for problem behavior?

2. How does this study extend previous applied research on the use of punishment?

3. What patterns of responding were observed during the functional analyses, and how were these results interpreted?

4. Describe the procedures and criteria used to identify the specific reinforcing and punishing stimuli that were used during the treatment conditions.

5. Describe the different experimental conditions and how they were combined and sequenced.

6. Summarize the results obtained with respect to SIB, object manipulation, and the frequency of punishment.

7. Small differences were observed for some participants between conditions in which punishment was used alone and those in which punishment was combined with reinforcement. Why, according to the authors, might these small differences be clinically important?

8. What explanations were provided by the authors to account for the increased effectiveness of punishment when it is combined with reinforcement?

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