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USE OF NEGATIVE REINFORCEMENT IN THE TREATMENT OF SELF-INJURIOUS BEHAVIOR

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Behavioral assessment procedures were used to determine the maintaining conditions of self-injury exhibited by 2 children with severe multiple handicaps. For both children, negative reinforcement (escape from grooming activities) was determined to be the maintaining reinforcer for self-injury (hand/arm biting) within an alternating treatments design. The treatment packages involved the use of negative reinforcement (brief escape from grooming activities) contingent upon a behavior that was incompatible with self-injury (reaching and pressing a microswitch that activated a prerecorded message of "stop"). Treatment was evaluated with a reversal design for 1 child and with a multiple baseline across grooming activities for the 2nd child. The treatment led to a marked decrease in self-injury for both children. At follow-up, high rates of self-injury were reported for the 1st child, but low rates of self-injury and an increase in task-related appropriate behavior were observed for the 2nd child.

DESCRIPTORS: functional analysis, negative reinforcement, severely handicapped, self-injurious behavior

Functional analysis procedures have proven effective in identifying maintaining conditions for self-injurious behavior (SIB). For example, Iwata, Dorsey, Slifer, Bauman, and Richman (1982) assessed the functional relationship between SIB and specific antecedent and consequence conditions with mentally retarded subjects and concluded that subjects' SIB was maintained by positive reinforcement (social attention or self-stimulation), negative reinforcement (escape from demands), or both. Durand and Carr (1985) also suggested that SIB may be maintained by both variations of positive and negative reinforcement and concluded that the selection of an appropriate treatment for SIB was dependent on the maintaining conditions.

Examples of the use of hypothesis testing or functional analysis procedures to prescribe treatments were reported by Repp, Felce, and Barton (1988) and Steege, Wacker, Berg, Cigrand, and Cooper (1989). Repp et al. (1988) successfully treated self-injurious and stereotypic behaviors of 3 severely handicapped children by first conducting behavioral assessments of self-injurious or stereotypic behavior during baseline conditions and then forming hypotheses about the variables maintaining the maladaptive behaviors and matching individual treatments. The results showed that a successful treatment program can be developed based on hypotheses regarding why a behavior occurred during baseline. Steege et al. (1989) combined behavioral assessments of reinforcer preference with functional analysis of SIB to prescribe individual treatment strategies for 2 children with severe multiple handicaps. Thus, the results of hypothesis testing or functional analyses of maintaining conditions can

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be used as a basis for selecting child-specific treatment strategies (Iwata, Pace, Kalsher, Cowdery, & Cataldo, 1990).

Although numerous studies have demonstrated the efficacy of interventions using punishment and/or positive reinforcement contingencies in the treatment of SIB, there are few published reports that demonstrate the application of negative reinforcement in the treatment of SIB. Iwata (1987), in his review of negative reinforcement, suggested the use of negative reinforcement as therapy, and Iwata et al. (1990) used escape extinction to treat SIB maintained by negative reinforcement. Durand and Carr (1987) also used negative reinforcement contingencies to treat stereotypic behavior.

Two interrelated areas of research have paralleled the development of functional analysis procedures. The first involves the use of electronic microswitches to increase habilitative functioning by individuals with severe multiple disabilities (e.g., Wacker, Wiggins, Fowler, & Berg, 1988). The second area of research, functional communication training (Carr & Durand, 1985), involves training an alternative behavior that serves as a replacement response for SIB. With both approaches, the child is trained to control outcomes by emitting a response. With respect to SIB maintained by negative reinforcement, the child might be trained to press a switch that requests a "break," thus serving as a replacement response for SIB. If the child received breaks for pressing the switch but does not receive breaks for SIB, it is plausible that quick reductions in SIB will occur.

In the present investigation, we conducted behavioral assessments to determine the maintaining conditions of SIB in 2 severely handicapped children. Based on the results of those assessments, we developed a treatment protocol that used microswitches to provide negative reinforcement as part of a treatment package to treat SIB.

METHOD

Participants and Setting

Ann, age 5, and Dennis, age 6, were referred to an inpatient treatment center for behavioral assessment and treatment of SIB. Both were nonambulatory, nonverbal, and diagnosed as profoundly mentally retarded. Neither child had independent communication skills, and both were dependent on others for self-care. All phases of the investigation were conducted in a classroom on a short-term hospital inpatient unit serving developmentally disabled children. One to 4 other patients and 1 to 3 staff members were present in the classroom at any given time.

Target Behaviors

Interviews with Ann's mother, classroom teacher, and in-home service worker indicated that Ann engaged in hand/wrist biting that occurred primarily during grooming activities (e.g., toothbrushing). Ann's SIB had been occurring since she was approximately 3.5 years of age and had escalated in frequency and intensity (causing open wounds) prior to admission. Interviews with Dennis's mother and classroom teacher indicated that his SIB involved hand biting, wrist biting, and arm (forearm and shoulder) biting behaviors that occurred primarily during grooming activities (e.g., toothbrushing, face washing, hair combing). Dennis had been engaging in SIB since he was approximately 2 years of age, and his SIB had increased in frequency and intensity (causing open wounds) prior to admission. On the day of admission, both subjects had open wounds resulting from their SIB.

Independent microswitch pressing was defined as unprompted pressing of a pressure-sensitive microswitch. Prompted microswitch pressing involved physical prompts by the therapist to the child to press the switch. Attempts to engage in SIB resulted in immediate discontinuation of the prompt. Appropriate behavior (assessed, in Dennis's case only, during maintenance) was defined as active participation (e.g., responding to instructional prompts by grasping grooming materials) in the grooming tasks. Therapist target behaviors included implementation of negative reinforcement and guided compliance procedures.

Materials

During assessment, materials included a soft-bristled toothbrush with toothpaste, a washcloth, a hairbrush, and miscellaneous developmentally ap-

propriate toys. The materials used during treatment included a soft-bristled toothbrush, a washcloth, a hairbrush, a pressure-sensitive (contact) microswitch (15 cm by 15 cm), and a battery-operated tape recorder.

Data Collection and Reliability

The first author, two graduate students in school psychology, and the classroom teacher served as observers. The observers used a 6-s partial-interval recording procedure to record occurrences and nonoccurrences of SIB, the occurrence of prompted and independent microswitch pressing, and appropriate behavior. Moreover, to measure procedural reliability, observers recorded occurrences of therapists' implementation of negative reinforcement contingencies (i.e., escape from task) and therapists' implementation of the guided compliance procedures. During 50% of the assessment/treatment trials and 50% of the maintenance trials (Dennis only), a second observer simultaneously but independently recorded target behaviors. Interobserver agreement was calculated by dividing the number of agreements by the total number of agreements plus disagreements and multiplying by 100. With Ann, the mean percentage of agreement for occurrence of SIB was 97% (range, 95% to 100%); was 98% (range, 96% to 100%) for nonoccurrence of SIB; and was 100% for independent microswitch activations, therapist's use of the negative reinforcement procedure, and therapist's use of the guided compliance procedure. With Dennis, the percentage of agreement for occurrence of SIB was 82% (range, 76% to 100%); was 87% (range, 79% to 100%) for nonoccurrence of SIB; and was 100% for independent microswitch activations, therapist's use of the negative reinforcement procedure, therapist's use of the guided compliance procedure, and appropriate behavior.

Design and Procedures

An alternating treatments design was used to evaluate the results of behavioral assessment of SIB for Ann and Dennis. With Ann, an ABABCB reversal design was used to evaluate the efficacy of the treatment of SIB. A multiple baseline across tasks design was used to evaluate the efficacy of the treatment of Dennis's SIB.

Assessment of self-injurious behavior. The SIB protocol was similar to the one described by Iwata et al. (1982). Assessment was conducted over 5 days with Ann and over 4 days with Dennis. Ann and Dennis were each exposed to four 10-min analogue conditions daily, with the order of conditions counterbalanced. Assessment trials were discontinued when biting resulted in opening of wounds and bleeding. Several assessment trials were less than 10 min long but none lasted less than 2 min. The four assessment conditions were (a) alone (child left alone in the classroom environment with no social interaction), (b) demand with a brief break from task (one trainer providing child with grooming tasks using a most-to-least restrictive prompt sequence and providing brief escape contingent upon SIB), (c) social attention (trainer present in classroom with child, providing social attention contingent upon occurrence of SIB), and (d) differential reinforcement of alternative behavior (DRA) (trainer engaging child in play activities, reinforcing appropriate behavior, and ignoring occurrences of SIB).

Baseline. During baseline with Ann, a trainer used physical prompts to brush her teeth. This involved the trainer approaching Ann, holding her chin with his or her left hand, and brushing Ann's teeth for 2 to 3 min. Escape from toothbrushing contingent upon SIB was not allowed. A return to baseline conditions was instituted following completion of the first treatment phase. After completion of the second treatment phase, a baseline condition identical to the behavioral assessment of SIB (i.e., toothbrushing with brief escape provided contingent upon hand biting) was conducted.

With Dennis, baseline involved a trainer using physical prompts to brush his teeth, wash his face, and comb his hair. Escape from grooming activities contingent upon occurrences of SIB was not permitted. All baseline sessions for both Ann and Dennis were conducted following breakfast, morning snack, lunch, or afternoon snack.

Treatment. An intervention package that incorporated negative reinforcement and guided compliance was implemented for both Ann and Dennis. Negative reinforcement involved providing brief

escape from the grooming activity contingent upon occurrence of the alternative behavior of reaching and pressing a microswitch that, when activated, played the message, "Stop!" The trainer terminated the grooming activity for 10 s when the child pressed the microswitch. If the child did not press the microswitch independently, the trainer physically prompted the child to press the microswitch contingent upon the child's cooperation with or tolerance of the therapist's completion of the grooming activity and subsequently permitted the child to avoid the grooming task for 10 s.

When the child engaged in SIB, the guided compliance strategy was implemented. Guided compliance involved hand-over-hand guidance of the child on the grooming task. If Ann or Dennis engaged in SIB during the 10-s escape from task, the trainer immediately reimplemented guided compliance.

Follow-up. On the day of Ann's discharge from the inpatient unit, a conference was held by the first and third authors with Ann's mother, classroom teacher, and in-home service worker. An explanation and a demonstration of the treatment procedures were provided. A videotape with an explanation and demonstration of the treatment procedures was mailed to the classroom teacher following Ann's discharge from the hospital unit.

On the day of Dennis's discharge from the hospital unit, a conference was conducted with Dennis's mother and the first and third authors. As in Ann's case, an explanation and a demonstration of the treatment procedures were provided. One week following discharge, the first author visited Dennis's classroom in his home community, met with interdisciplinary team members, reviewed the results of the behavioral assessment, explained the treatment procedures, and provided a demonstration of the treatment procedures.

RESULTS

Results of the functional analysis of Ann's SIB are shown in Figure 1. During the first 2 days of assessment, SIB occurred at similar rates across the assessment conditions. Beginning with the 3rd day of assessment, SIB occurred most frequently in the demand condition. A gradual increase in SIB occurred within the demand condition, with steady but low rates of occurrence of SIB in the alone, social attention, and DRA conditions. These data suggested that Ann's SIB was maintained primarily by negative reinforcement (i.e., escape from demands). These data were consistent with accounts provided by Ann's mother and classroom teacher.

The results of Ann's treatment package are presented in Figure 2. During the initial baseline phase, SIB occurred during 20% of the observation intervals and increased to 62% during the third session. When negative reinforcement and guided compliance strategies were implemented, an immediate decrease (10%) in SIB resulted, with no SIB occurring during the next two sessions. During a return to baseline, SIB increased to previous baseline levels. When treatment was reimplemented, a decrease of SIB again occurred, with no hand biting observed during the final two sessions. This was followed by introduction of a phase identical to the demand condition conducted during assessment (i.e., escape contingent upon hand biting), resulting in an increase in SIB. Finally, when the treatment was reimplemented, a decrease in SIB resulted, with only one incident of hand biting occurring during the final three sessions. Ann independently pressed the microswitch on only one occasion, during the next-to-last treatment session.

The results of behavioral assessment of SIB with Dennis are presented in Figure 3. Across four assessment sessions, SIB consistently occurred at high rates (45% to 57%, $M = 52\%$) during the demand condition and at low rates ($\leq 12\%$, $M = 8\%$) during the alone condition. SIB was observed during only the third session (8%) of the social attention condition and did not occur during the DRA condition. These data suggested that Dennis's SIB was maintained primarily by negative reinforcement (i.e., escape from demand activities).

The results of treatment of SIB with Dennis are shown in Figure 4. During baseline, Dennis displayed high rates of SIB ($M = 54\%$ during toothbrushing, $M = 70\%$ during face washing, and $M = 58\%$ during hair brushing). When treatment

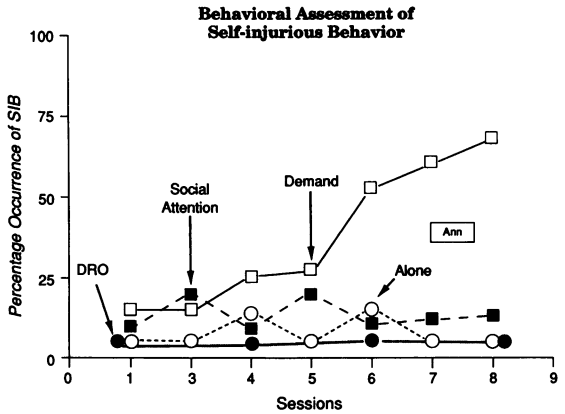

Figure 1. Functional analysis of maintaining conditions for Ann.

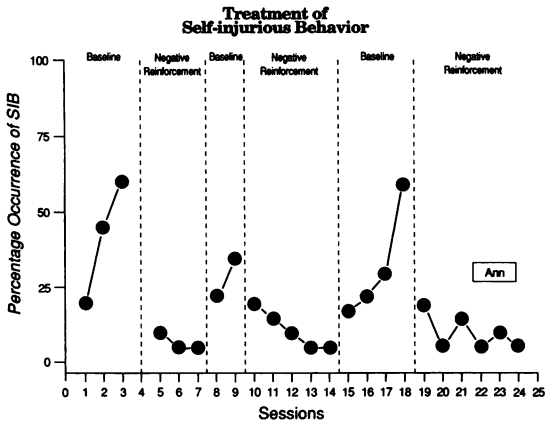

Figure 2. Percentage occurrence of SIB during baseline and treatment for Ann.

was implemented during toothbrushing, an immediate decrease in SIB resulted, with consistently low rates of SIB occurring throughout treatment. During the face-washing task, an immediate decrease in SIB occurred, with SIB occurring only once during the final eight sessions. With the hair-brushing task, no occurrences of SIB occurred during treatment.

As shown in Figure 5, independent (self-initiated) microswitch activation occurred first during the 11th treatment session (14th session overall) of toothbrushing, the seventh treatment session of face washing, and the first treatment session of hair brushing. Frequency of trainer prompts to press the microswitch ranged from a low of one prompt (third session of toothbrushing, second and third sessions of face washing) to a high of 10 prompts (eighth and tenth sessions of toothbrushing). During maintenance (see Figure 4), low rates of SIB were observed: 5% and 8% during toothbrushing, 5% and 0% during face washing, and 4% and 0% during hair brushing. Conversely, high rates of appropriate behavior were observed during each of the three grooming activities: 80% and 82% during toothbrushing, 85% and 88% during face washing, and 80% and 100% during hair brushing. Dennis independently pressed the microswitch on five occasions during both toothbrushing trials, once during each of the face washing trials, and three times and once, respectively, on the hair brushing trials (see Figure 5).

One year after discharge, a telephone contact to Ann's classroom teacher was made by the first author. The teacher indicated that neither she nor Ann's mother had implemented the training procedures and that SIB continued to occur at high rates during grooming conditions.

Six months after discharge, Dennis was readmitted to the inpatient unit for the primary purpose of positioning in his wheelchair with a new postural support seating system. Review of Dennis's SIB was evaluated at that time by repeating the treatment conditions. As shown in Figures 4 and 5, Dennis was now actively involved in grooming activities and was engaging in very low rates of SIB.

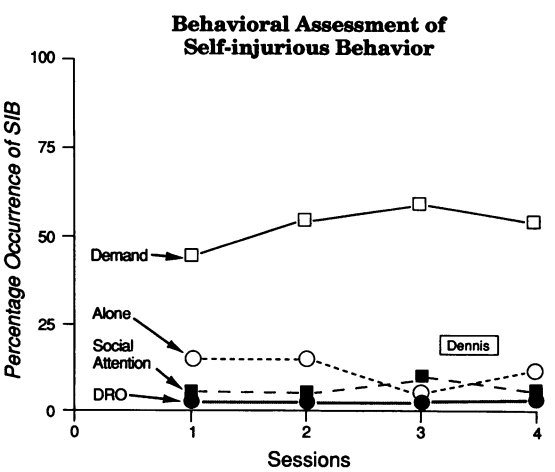

Figure 3. Functional analysis of maintaining conditions for Dennis.

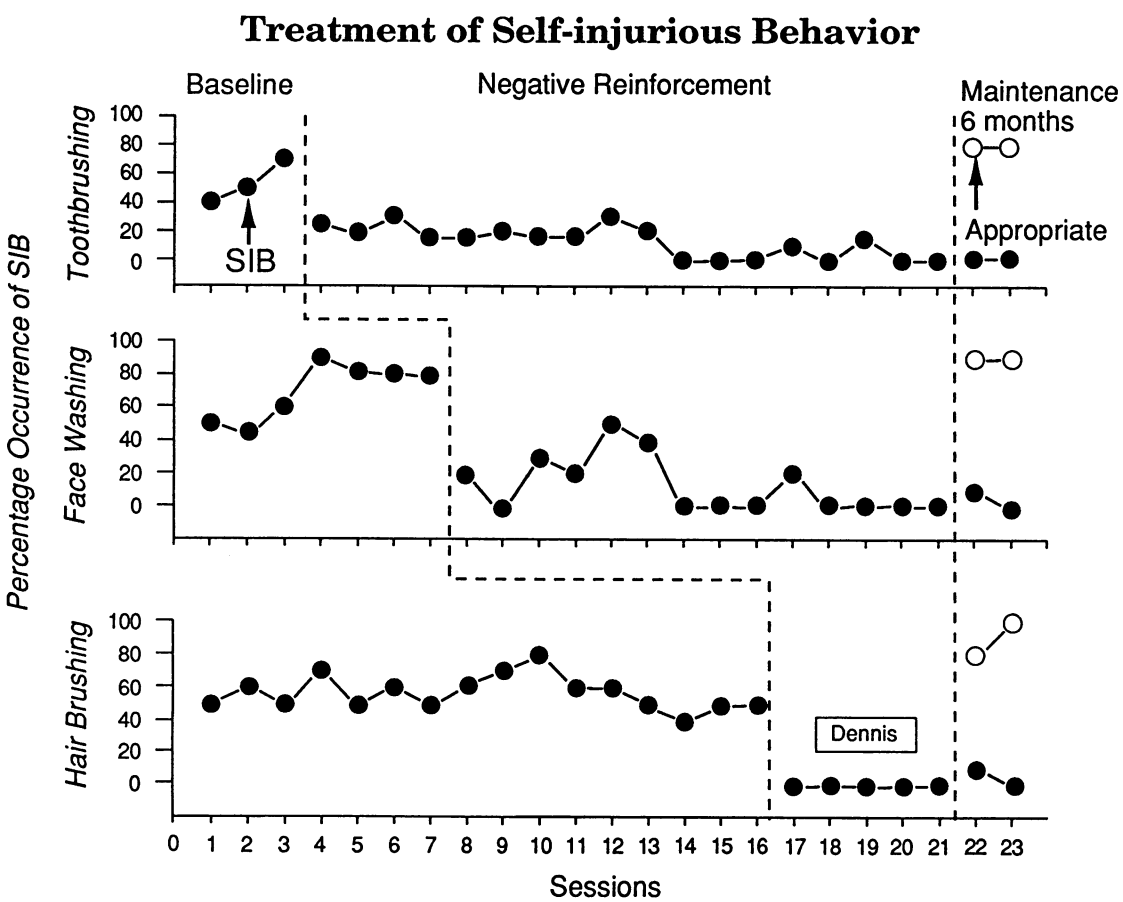

Figure 4. Percentage occurrence of SIB during baseline, treatment, and follow-up for Dennis.

DISCUSSION

The use of functional analysis procedures, as described by Carr and Durand (1985) and Iwata et al. (1982), has been associated with rapid growth in the number of published investigations on the assessment of SIB. In every case, the maintaining conditions controlling SIB have been identified as being of more relevance than the topography of target behavior, thus permitting the selection of effective treatment (Iwata et al., 1990).

There also has been increased attention provided to negative reinforcement as a viable option for treatment (Iwata, 1987). In a few cases in which negative reinforcement has been used for treatment, the results have been impressive across diverse topographies of behavior (e.g., Durand & Carr, 1987; Iwata et al., 1990; Weeks & Gaylord-Ross, 1981). Of equal importance is the variety of treatment approaches used by these investigators to eliminate or reduce maladaptive behavior maintained by escape, including extinction (Iwata et al., 1990), reduction of task demands plus stimulus fading (Weeks & Gaylord-Ross, 1981), requesting help (Durand & Carr, 1987), and differential reinforcement of appropriate behavior plus graduated guidance (Steege et al., 1989).

The current investigation extended these findings by demonstrating that negative reinforcement could be used directly during the treatment process. Providing negative reinforcement contingently on cooperative behavior and guided compliance for SIB led to decreases in SIB for both Ann and Dennis, while maintaining participation in needed activities. Although Ann independently pressed the microswitch on only one occasion, the low rates of SIB

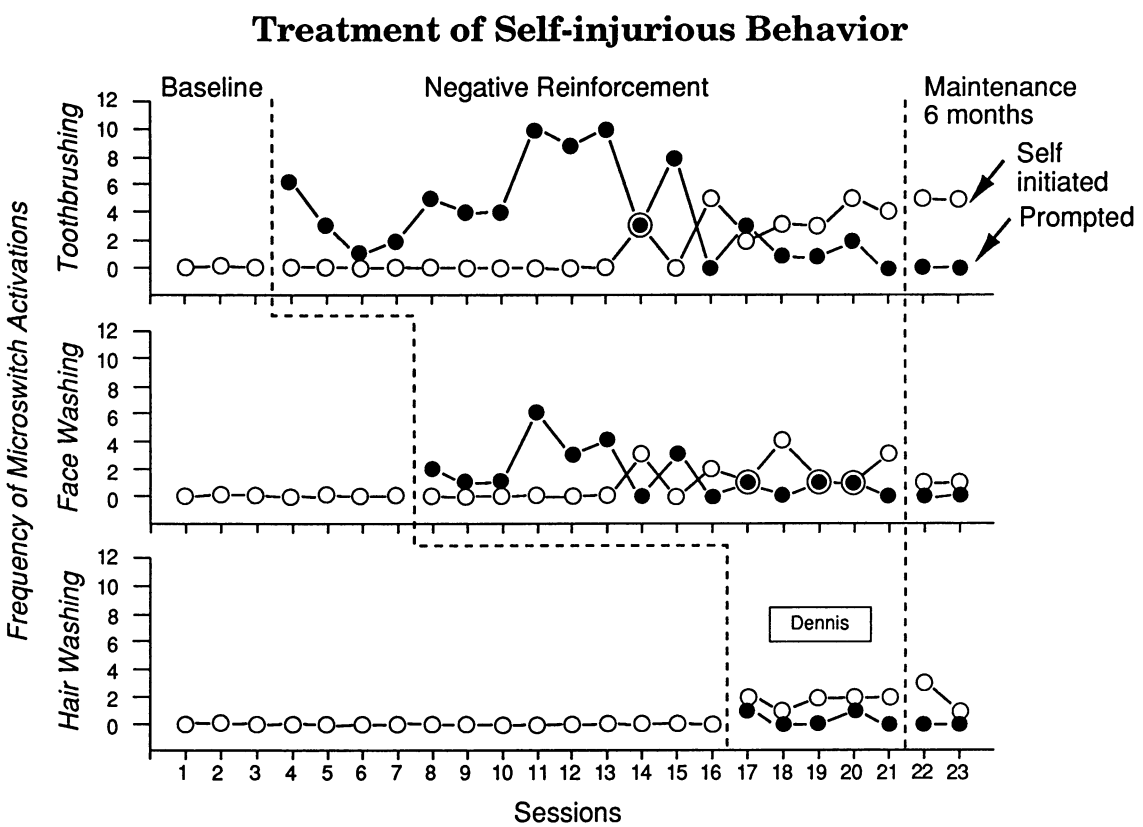

Figure 5. Self-initiated and prompted microswitch activation during baseline, treatment, and follow-up for Dennis.

during treatment appeared to be related to changes in the delivery of negative reinforcement. Specifically, during baseline, escape from the grooming task was not permitted and high rates of SIB were observed, suggesting a possible response burst associated with extinction (i.e., no escape). During behavioral assessment conditions, escape from tasks was contingent only upon SIB. The treatment of escape from task (negative reinforcement) prior to occurrence of SIB suggests that providing an identified reinforcer contingent upon a cooperative response and prior to the occurrence of SIB leads to a strengthening of the former and a reduction of the latter. Dennis, on the other hand, learned to activate the microswitch independently, leading to an increase in microswitch pressing and a concomitant decrease in SIB.

Both children completed the assigned activities; for example, both children received toothbrushing at the scheduled times. The inclusion of the escape component simply increased the amount of time needed to complete the activities, because breaks were built into those activities. During the initial phases of treatment, the duration of grooming tasks was increased from baseline levels of 2 to 3 min to treatment durations of 3 to 4 min. However, during the later stages of treatment (as Ann and Dennis became more cooperative), the duration of grooming activities was equal to and often reduced from baseline levels. Our anecdotal observations indicated that, for toothbrushing, both children actually increased their time on task, and grooming tasks were completed with greater quality as a result of treatment. Future investigators who use negative reinforcement contingencies might consider conducting direct observations of time on task, prior to and after treatment, to substantiate these anecdotal findings. If possible, data on the quality of performance should also be monitored (perhaps by nursing or dental personnel).

It is important to note that our treatment package involved two distinct components: (a) training that provided escape contingent upon pressing the microswitch and (b) guided compliance contingent upon SIB. Both components were based on escape as comprising the primary function of SIB, with the escape response serving as negative reinforcement and guided compliance resulting in mild punishment. A component analysis was not conducted to isolate the separate contributions of each component, but the recent investigation of Wacker et al. (1990) suggests that both components are needed for the rapid results achieved. In the Wacker et al. analysis, guided compliance and functional communication training were also combined to achieve quick reduction of maladaptive behavior for 1 child who engaged in aggressive behavior. If quick results are considered important for treatment, then consequences for both appropriate and inappropriate behavior may be needed. When extinction is used for inappropriate behavior, the rapidity of treatment effects varies substantially (e.g., Carr & Durand, 1987; Iwata et al., 1990) depending on the history of responding and the efficiency of the replacement behavior (Carr, 1988). Given both the severity of the behavior displayed by these children and the short-term nature of their admission, we decided to include guided compliance as a treatment component.

Examination of the generality of our findings in school and home settings is an important and logical next step in the treatment of SIB. As demonstrated in this investigation, if treatment is not used at home or school, maintenance will not occur. For Ann, her mother and teacher decided not to implement the treatment, resulting in a lack of generalization and maintenance. A number of variables may be responsible for this outcome, including the lack of an on-site visit and insufficient follow-up consultation. Moreover, the treatment intervention may have been considered by caregivers as being complicated and arduous and not applicable to the home and school settings.

Two directions for future researchers who are concerned with maintenance appear plausible. First, as discussed previously, when a treatment match is first identified, there are invariably a number of distinct treatment options available. Once these options are identified, the consumers might be asked to rate the acceptability (Reimers & Wacker, 1988) of available treatments relative to their applicability to the home and school settings. Second, the analysis and treatment of SIB should be implemented more often in school and home settings and/or by parents and teachers, thus reducing the amount of transfer needed between the treatment and home or school settings.

The relative effectiveness of various communication responses with specific subjects should be investigated further. With respect to children with severe multiple handicaps, evaluation of the relative effectiveness, efficiency, saliency, and cost effectiveness of a variety of communication methods (e.g., signing, augmentative communication device) is needed. This investigation replicates previous findings of investigators who have reported success in using microswitches as part of treatment packages (Steege et al., 1989; Wacker et al., 1988). Microswitches that activate pretaped messages have the advantage of providing salient cues to therapists that are not easily ignored, increasing the probability of immediate consequences. The use of signs or other motoric behavior may go unnoticed or may even be ignored, whereas the activation of pretaped messages can be made as salient as needed by adjusting the volume. This may be an important aspect of our treatment package and, in our view, outweighs the relative disadvantages (e.g., set-up of equipment) for many clients.

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