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REDUCTION OF AUTOMATICALLY-MAINTAINED SELF-INJURY USING CONTINGENT EQUIPMENT REMOVAL

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This study reports the use of contingent removal of protective equipment to reduce the severe head-directed self-injurious behavior of an 8-year-old boy with autism. Treatment was initially implemented in a highly controlled environment, and was then generalized to the participant's classroom, residence, and following his discharge, to his home environment. The treatment effectively reduced self-injurious behavior to near-zero levels. Systematic fading of the protective equipment was started but not completed due to his previously-planned discharge. Copyright © 2007 John Wiley & Sons, Ltd.

INTRODUCTION

Automatically-maintained problem behavior is a particular challenge for applied behavior analysts (Piazza, Adelinis, Hanley, Goh, & Delia, 2000). The conclusion that behavior is maintained by automatic reinforcement is typically made by ruling out alternative, social sources of reinforcement through functional assessment. This conclusion is tentative since assessment does not identify the specific consequence that maintains problem behavior, but rather identifies what is *not* the reinforcer (Piazza et al.). Another complicating factor is that the behavior analyst cannot readily control the participant's access to the reinforcer. Thus, the reinforcer is continuously available to the participant (Piazza et al.).

Treatment strategies for automatically-maintained responding have included attempts to attenuate the sensory consequences of the response, referred to as sensory extinction (Rincover, Cook, Peoples, & Packard, 1979), and response independent,

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continuous access to alternative sources of stimulation that match the hypothesized sensory consequences of the problem behavior (e.g., Piazza et al., 2000). For both of these treatments, a hypothesis about the likely sensory consequences maintaining the behavior is made and then treatment is based on this hypothesized reinforcer. With sensory extinction, the hypothesized reinforcer is either attenuated or the response is blocked thereby effectively discontinuing access to the reinforcer. Some have speculated that the behavioral mechanism accounting for its effectiveness is extinction (e.g., Reid, Parsons, Philips, & Green, 1993; Rincover et al.). In the response independent strategy continuous access to matched stimuli is presumed to be a motivating (specifically, abolishing) operation that decreases the effectiveness of the response-produced stimulation as a reinforcer, thereby reducing the problem behavior. It must be noted, however, that response prevention may also change behavior through punishment (Lerman & Iwata, 1996).

In the case of automatically-maintained severe self-injurious behavior (SIB), it is difficult to identify the specific sensory consequence that maintains behavior and even more difficult to provide alternative, appropriate forms of that stimulation. Thus, intervention through the use of matched stimulation may not be possible. Protective equipment or restraint devices may be desirable as emergency interventions to prevent injury and can be combined with other interventions as part of a longer-term treatment strategy.

The effectiveness of contingent and noncontingent protective equipment in the treatment of SIB has been well documented (Favell, McGimsey, & Jones, 1978; Dorsey, Iwata, Reid, & Davis, 1982; Foxx & Dufresne, 1984; Foxx, 1990; Fisher, Piazza, Bowman, Hanley, & Adelinis, 1997), although the behavioral mechanism accounting for this effectiveness is not always clear (Mazaleski, Iwata, Rodgers, Vollmer, & Zarcone, 1994). Once effective reduction of SIB has been achieved and appropriate alternative responses are established the restraints are systematically faded.

Systematic restraint fading may include (a) fading the physical characteristics of the restraint device (e.g., size or restrictiveness); (b) fading the temporal characteristics of the treatment (i.e., the duration of application or removal of the restraints); and, (c) when restraints function as reinforcers, providing the restraint for progressively longer periods without SIB, for increasing periods of appropriate behavior, or both.

In the present case study an experimental analysis of SIB indicated that it was not likely mediated by social contingencies. Response independent application of protective equipment was combined with equipment removal contingent on SIB to reduce the severe fist-to-head SIB of a young boy with autism. Once low rates of SIB were established, the program was implemented in the participant's classroom and residence and systematic fading of the equipment was conducted.

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METHOD

Participant

The participant, Colin, was an 8-year-old boy referred to the New England Center for Children's Staff Intensive Unit for treatment of severe SIB. Colin had been diagnosed with autism at the age of 2. Since being diagnosed, Colin received early intervention services at home. At the age of 4, Colin began to engage in SIB, which progressively worsened. Although he engaged in multiple topographies of SIB, the topography that was of greatest concern was head-directed closed-fist punches. Colin received 1:1 staffing throughout his waking hours.

Setting and Materials

All sessions were conducted in a 2 m by 4 m therapy room equipped with a one-way observation mirror and a video camera. All sessions were video taped. Generalization probes were conducted in Colin's classroom, which he shared with two other students. The classroom contained tables and chairs, shelves with toys and academic materials. He could also be observed from an adjacent room through a one-way observation mirror.

A soft foam karate helmet (Macho® brand) with an attached plastic face cage (ProForce® head guard) was used as the protective equipment. During helmet fading (described below) the helmet was cut into 10 pieces that were then reassembled with duct tape. Pieces of the helmet could then be systematically removed and replaced based on Colin's level of SIB during treatment.

Data Collection and Interobserver Agreement

Frequency data were collected for SIB and helmet removal during all sessions. SIB was defined as any open- or closed-fist hand-to-head or fist-to-body contact; knee-to-head contact from any distance; or leg-to-leg contact. Hits to the helmet were counted as instances of SIB. Treatment integrity was defined as removing the protective helmet within 5 s of the occurrence of SIB. During both the functional analysis and treatment assessments, a designated data collector observed all sessions. During generalization probes, maintenance, and helmet fading, Colin's teacher collected data. A second observer independently collected data from videotapes of sessions. During functional analysis and treatment assessment 30.2% of sessions were scored for interobserver agreement. During helmet fading 23.1% of sessions were scored for interobserver agreement and treatment integrity. Agreement on SIB between observers was calculated by dividing the lower number of SIB by the higher number of SIB and multiplying by 100. Treatment integrity was calculated by

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dividing the lower number of helmet removals from one of the observers by the higher number from the other observer and multiplying by 100. Mean interobserver agreement and treatment integrity were 96.3% and 93.8%, respectively.

Procedures

Functional Analysis

A functional analysis of Colin's SIB was conducted according to the procedures described by Iwata, Dorsey, Slifer, Bauman, and Richman (1982/1994). During the attention condition, an experimenter sat in the room with Colin. Colin had access to moderately preferred toys and the experimenter read a magazine. Contingent on SIB, the experimenter walked over to Colin, held his hand and in a concerned tone of voice told him to stop hitting himself. This condition evaluated whether Colin's SIB was sensitive to social positive reinforcement. During the demand condition, the experimenter presented Colin with demands similar to those routinely delivered in his classroom and residence every 5 s using a least-to-most prompting hierarchy (verbal, model and manual guidance). Compliance to demands was followed by verbal praise. Contingent on SIB, the experimenter said ''You don't have to do it'' and demands were withheld until no SIB had occurred for 15 consecutive seconds. This condition evaluated whether Colin's SIB was sensitive to escape from demands. To test if Colin's SIB was maintained in the absence of social positive or social negative reinforcement, Colin was observed while alone, without any toys, in the therapy room. During the play condition, Colin had access to the same toys as during the attention condition; the experimenter read a magazine but approached Colin every 15 s, put his hand on Colin's shoulder and praised him for playing with the toys. The play condition served as a control condition. Colin wore the protective helmet throughout the functional analysis because of the severity of his SIB. Colin engaged in high rates of head-directed and other SIB, even while wearing the helmet.

Ten-minute sessions of attention, demand, alone, and play were initially alternated unsystematically. After 26 sessions, the order of conditions was kept constant, in an effort to enhance discrimination between the conditions, as suggested by Iwata et al. (1994). The play condition was the first condition each day followed by alone, attention and then demand.

Treatment Assessments

Colin wore the protective helmet continuously throughout all treatment and helmet fading phases, except as described below. Treatment was first assessed in 10-min sessions with a pairwise comparison of continuous access to protective equipment and

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contingent removal of protective equipment. During *continuous access to protective equipment* Colin wore the helmet throughout the session, and there was no programmed consequence for SIB. During *contingent removal of protective equipment*, Colin wore the helmet from the beginning of the session. Contingent on any instance of SIB, the experimenter removed the helmet and prompted Colin to fold his hands and count out loud to 10. The experimenter reapplied the helmet once Colin counted without engaging in SIB. On occasion Colin continued to engage in SIB and did not comply. Contingent on 30 instances of SIB without the helmet the experimenter manually guided Colin to fold his hands and then counted to 10 for him (at the rate of approximately one per second). A second person applied the helmet and then the experimenter released Colin's hands. If Colin engaged in SIB within 1 min of helmet reapplication, the experimenter removed the helmet and manually guided Colin through tasks until he stopped attempting to engage in SIB.

Following 30 sessions of treatment assessment, 60-min generalization probes were conducted by the experimenter in Colin's classroom to determine if treatment would be effective for a longer duration and in a less controlled environment. During generalization probes, Colin participated in regularly-scheduled activities and the consequence for SIB was removal of the helmet. Next, a multiple baseline design across teachers was used to assess the generality of the treatment across therapists. Colin's teachers served as therapists. Baseline during the multiple baseline assessment was similar to the demand condition in the functional analysis; however, there were no programmed consequences for SIB. Demands were delivered every 5 s using a least-to most prompting hierarchy. Correct responding was followed by praise.

When the treatment assessments, generalization probes, and multiple-baseline assessments were completed, all of Colin's teachers and overnight staff were trained to implement the treatment. Training consisted of individual meetings, role play and observations. Once teachers and overnight staff had been trained, treatment was implemented across the entire day.

Helmet Fading

At the beginning of this phase a baseball cap with the brim removed was placed inside the helmet. Intervention for SIB during this phase was the same as in the treatment assessment phase. Helmet-fading sessions were designed to be as similar to Colin's daily activities in the classroom as possible. Nine-trial academic sessions were interspersed with 2–3 min breaks during 30-min observation and data collection periods. During breaks, Colin had access to toys selected from his classroom. During academic work, correct responses were followed by tokens that could be exchanged for edible reinforcers. Colin's regular teaching staff worked with him during all his

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waking hours. Following some sessions in this phase, helmet-removal probes were conducted to determine if continued systematic helmet fading was necessary. During these probes, the helmet was removed, and Colin wore only the baseball cap. The probe session started when the therapist removed the helmet and the latency to the first occurrence of SIB was recorded. Each probe was terminated following the first occurrence of SIB, and the regular intervention plan was followed.

Helmet fading was based on Colin's SIB throughout the day. The criteria for fading the helmet were three consecutive days with zero hits to the helmet, 100% independence counting to 10 following helmet removal, fewer than 30 SIB (all topographies) during the day, and fewer than 10 SIB (all topographies) during the overnight hours. As described above, the helmet had been cut into 10 pieces and reassembled with duct tape. When the criteria for helmet fading were met, a predetermined piece was removed during the overnight hours.

RESULTS

The functional analysis indicated that Colin's SIB was not likely maintained by social consequences, as can be seen in Figure 1. Frequency of SIB was variable across

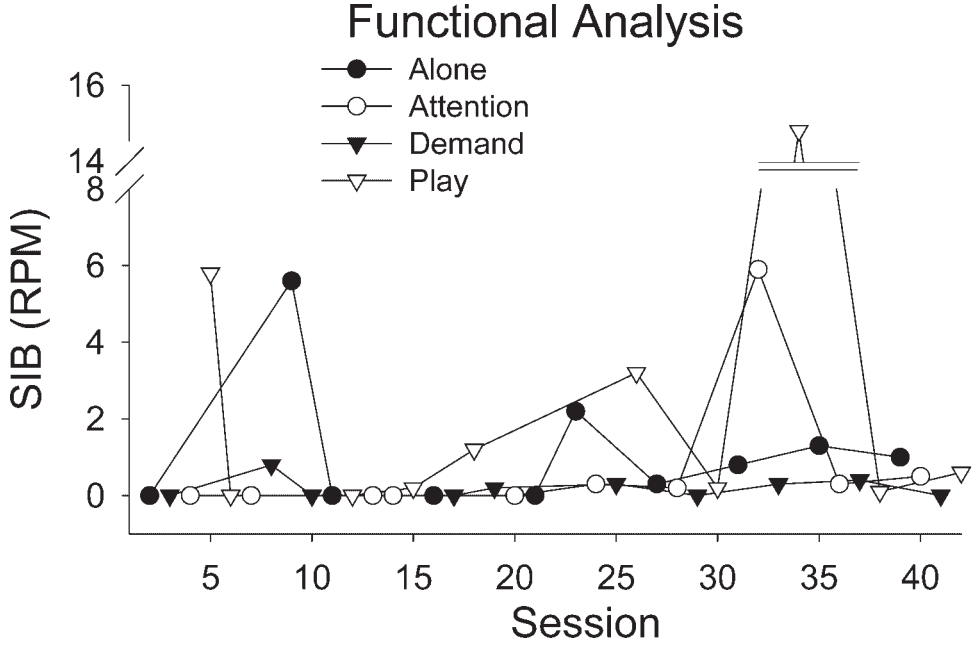

Figure 1. Responses per min (RPM) of SIB during functional analysis of Colin's SIB.

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all conditions of the functional analysis with generally higher levels of SIB observed during the alone and play conditions. Implementing a fixed order of conditions after session 26 did not have an effect on the rate of SIB during the assessment.

The results of the pairwise treatment evaluation are presented in Figure 2. Colin's SIB remained high and variable in the continuous access to protective equipment (PE) condition. During contingent helmet removal sessions, the rate of SIB dropped immediately to near-zero levels. During the generalization probes Colin exhibited no SIB.

The results of the multiple-baseline-across-teachers phase of the treatment assessment can be seen in Figure 3. SIB remained at a high variable rate during baseline across both therapists. Once teacher 1 implemented the treatment, levels dropped immediately to near zero. Concurrently, the rate of SIB decreased during baseline sessions with teacher 2 but SIB subsequently increased with this teacher. Once teacher 2 implemented the treatment, SIB dropped immediately to near zero levels. Colin sometimes did not immediately comply with counting aloud when the helmet was removed. These occasions resulted in higher rates of SIB, as can be seen at session 13 (teacher 1) and session 15 (teacher 2).

During fading sessions (see Figure 4; note the difference in ordinate scales between Figures 3 and 4), SIB remained at near-zero levels with occasional occurrences of

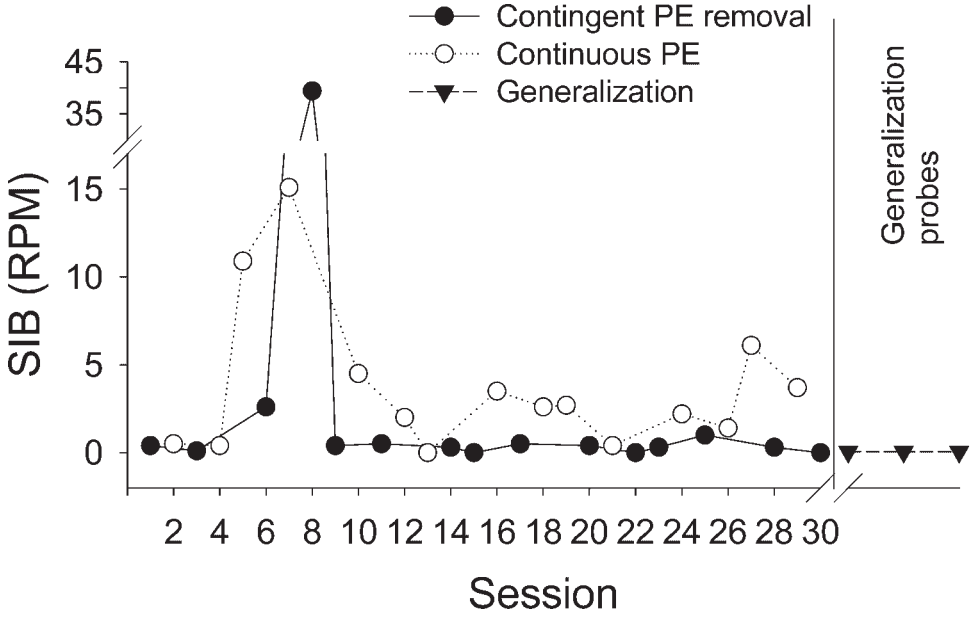

Figure 2. Responses per min of SIB during treatment assessment (multiple treatment design).

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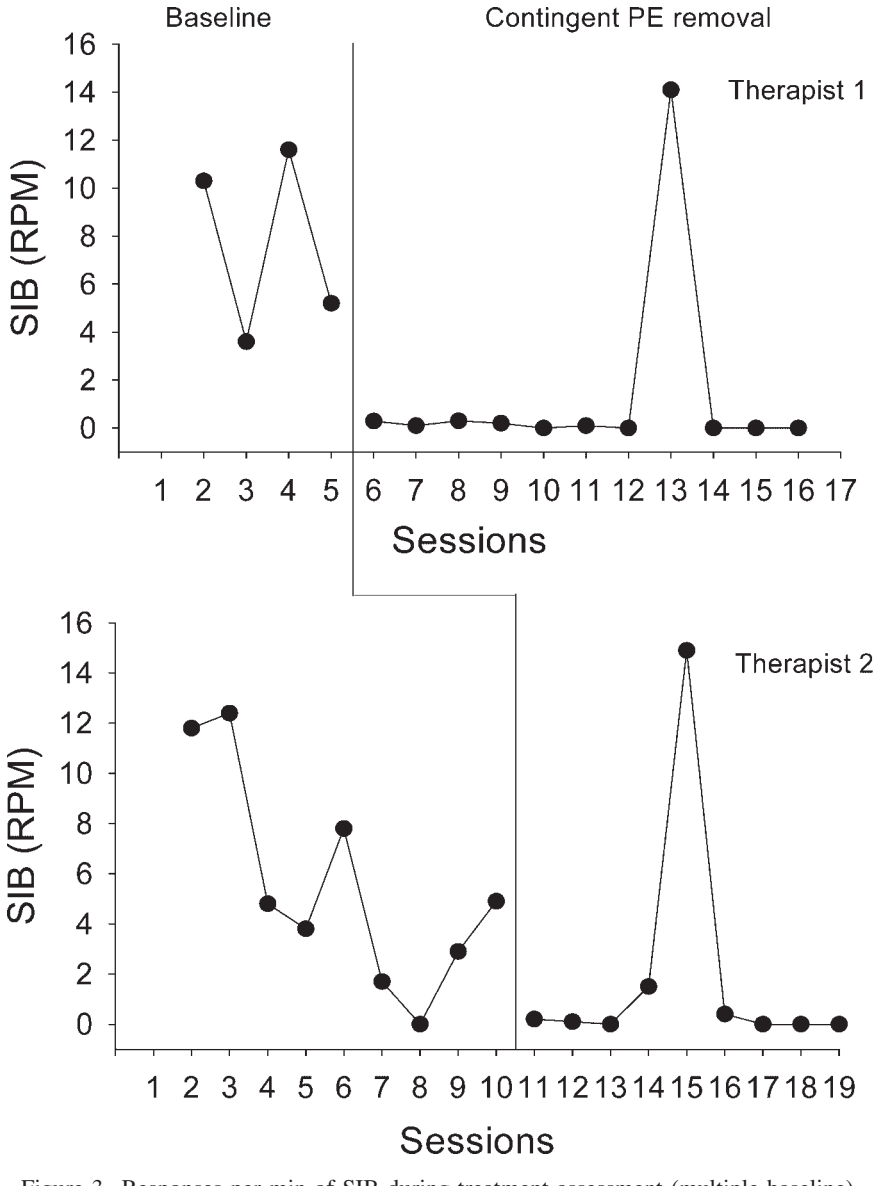

Figure 3. Responses per min of SIB during treatment assessment (multiple baseline).

SIB. Beginning at session 40 there was a persistent increase in Colin's SIB. Therefore, a lengthy period elapsed during which the helmet was not faded. Following session 74 Colin was discharged from the NECC Staff Intensive Unit and a home-based program was established. Colin's discharge date had been previously determined and

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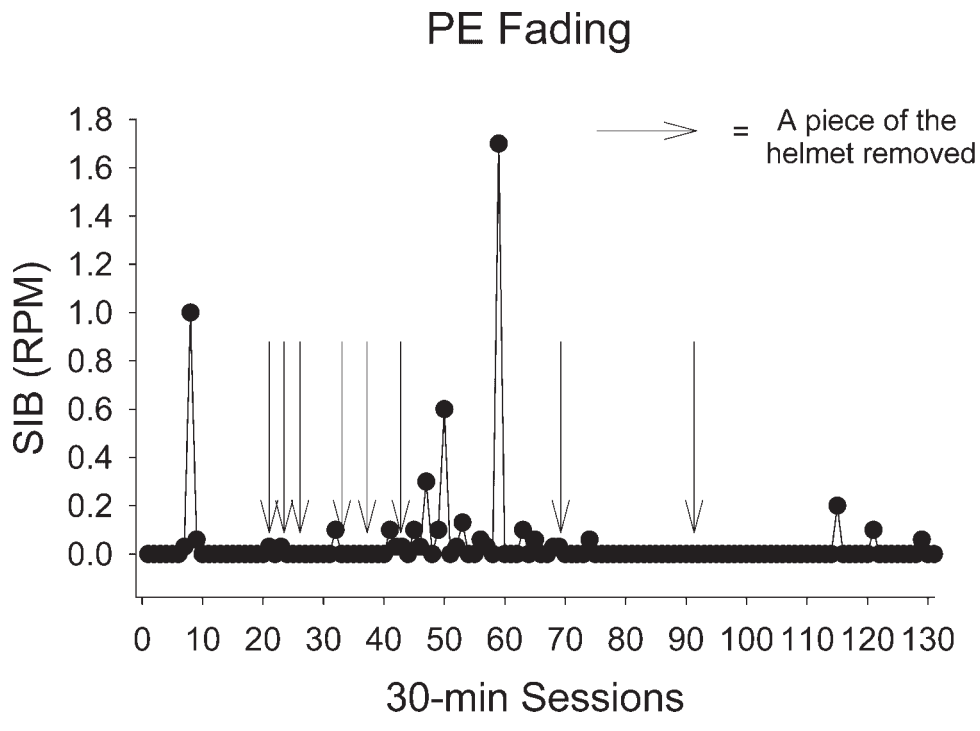

Figure 4. Responses per min of SIB during equipment fading.

was not related to the current intervention. Data collection continued at home, however, helmet fading was discontinued during the transition period. Following session 131, data collection for the purpose of the present study ended. Anecdotally, Colin continued to exhibit low rates of SIB, and his program was successfully implemented in a supported public-school classroom. At the time of this writing, low rates of SIB had been maintained for nearly 2 years, although occasional brief bursts of responding continued to occur.

Data from the probe sessions during helmet fading are presented in Figure 5. When the helmet was removed during probes, the mean latency to the first occurrence of SIB was 5.9 s, with the longest latency being 17 s.

DISCUSSION

The contingent helmet removal was an effective treatment for Colin's SIB. SIB immediately decreased to near-zero levels upon implementation of the

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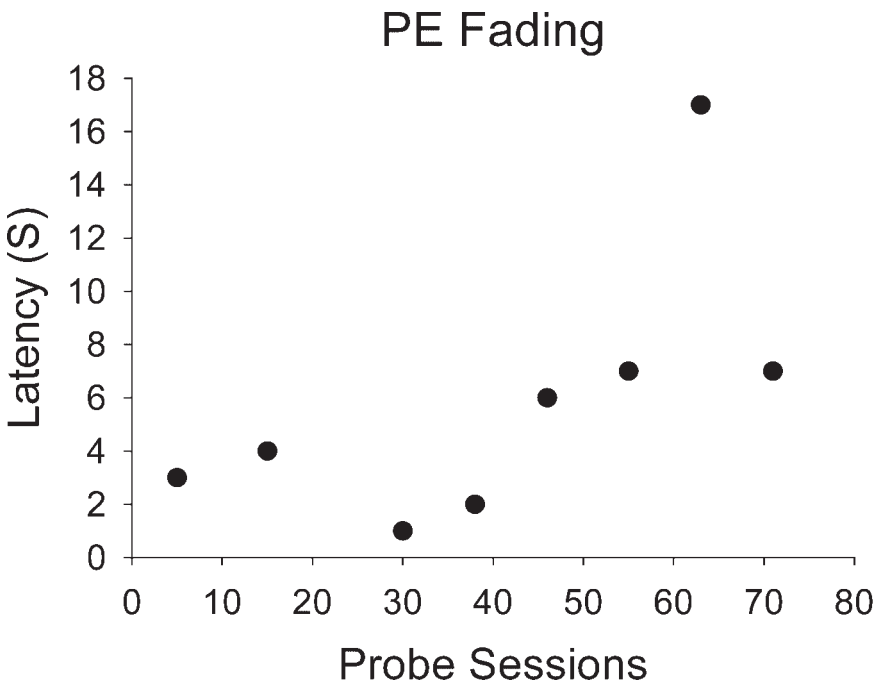

Figure 5. Latency to SIB after removal of protective equipment in probe sessions during equipment fading.

procedure during the treatment assessment, generalization probes, and multiple-baseline-across-teachers phases. Helmet fading was also successful, although it was not completed before Colin's predetermined discharge date.

This study extends the literature on treatment of severe challenging behavior by demonstrating the systematic development and evaluation of a complex treatment procedure in an analog environment and the subsequent generalization of the procedure to the regular classroom and residential program across the day. The treatment program was then successfully transferred from this highly-structured, intensive residential program to a home- and public school-based program.

While this treatment was clinically effective, the behavioral mechanism responsible for its effectiveness is less clear and was not the purpose of this study. Contingent application of protective equipment may reinforce behavior (e.g., Foxx & Dufresne, 1984), may result in extinction, or may punish behavior (e.g., Mazaleski et al., 1994). While numerous studies have investigated contingent *application* of protective equipment, there seems to be limited investigation of contingent *removal* of protective equipment (cf., Fisher et al., 1997). In the present case, we observed that

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Colin frequently became agitated when helmet removal was necessary during activities of daily living. Colin's apparent emotional responding (agitation, crying, and other tantrum behaviors) led us to hypothesize that helmet removal was aversive and thus, contingent removal might function as response cost or time-out. Our initial plan was to remove the helmet contingent on SIB, and reapply it contingent on increasing periods of appropriate, alternative behavior. Thus, we would use helmet removal to simultaneously reduce SIB and to increase an appropriate alternative behavior. A limitation of this approach in the present case was the lack of a systematic demonstration that contingent application of the helmet functioned as a reinforcer. A second limitation of this approach was that, because of Colin's extremely short latency between helmet removal and SIB, we were not able to effectively increase the duration of appropriate alternative behavior during helmet removal. This led to the decision to focus on fading the physical properties of the helmet instead.

Further investigation of the functional properties of the helmet could have included systematically assessing the helmet as a positive reinforcer. For example, the helmet could have been provided contingent on an arbitrary response; if contingent helmet application increased or maintained this response we would have concluded that helmet application could reinforce responding. Such an assessment would have clarified the behavioral mechanism responsible for the effectiveness of the present treatment.

Procedures involving the removal of protective equipment contingent on self-injurious behavior must be carefully designed and monitored. During equipment removal, the client is at risk of causing the self-injury that the equipment is intended to prevent. Additionally, if the equipment functions as a reinforcer, then reapplication of the equipment must not closely follow instances of SIB. Manual guidance, physical blocking, or physical restraint may be used to prevent SIB during equipment removal. This can help assure compliance during equipment removal; however these procedures may themselves reinforce self-injury (e.g., Vollmer & Vorndran, 1998) and thus must be used with caution.

In summary, this case study illustrates the use of protective equipment removal to effectively reduce severe challenging behavior. The procedure was initially developed and assessed in an analog environment and then transferred to the classroom, residence, and eventually a home-based program.

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