JOURNAL OF APPLIED BEHAVIOR ANALYSIS 1994, 27, 345–355 NUMBER 2 (SUMMER 1994)

PROTECTIVE EQUIPMENT AS TREATMENT FOR STEREOTYPIC HAND MOUTHING: SENSORY EXTINCTION OR PUNISHMENT EFFECTS?

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We examined the effects of noncontingent and contingent protective equipment as treatment for self-injurious hand mouthing exhibited by 2 individuals with profound mental retardation. Results of a functional analysis assessment revealed that neither subject's self-injury was maintained by social reinforcement: One subject's self-injury was cyclical in nature; the other's occurred during all assessment conditions but most frequently when left alone. In the noncontingent-equipment condition, oven mitts were placed on the individual's hands at the beginning of a session and remained on throughout. In the contingent-equipment condition, the mitts were briefly placed on the individual's hands following occurrences of hand mouthing. For 1 subject, noncontingent mitts produced a large decrease in the rate of hand mouthing and contingent mitts produced similar results following a return to baseline. Hand mouthing was also reduced in the 2nd subject, but this individual was exposed only to the contingent-equipment condition (i.e., there was no prior history with the noncontingent-equipment condition). These results suggest either a punishment or a time-out interpretation rather than an extinction interpretation to account for the behavior-reducing effects of contingent protective equipment on self-injury.

DESCRIPTORS: functional analysis, protective equipment, self-injurious behavior, sensory extinction

Research on the functional analysis of self-injurious behavior (SIB) has indicated that SIB in some individuals is not maintained by social consequences (e.g., Iwata, Dorsey, Slifer, Bauman, & Richman, 1982). SIB of this type has been described as *stereotypic* behavior, and a number of theories have been proposed to account for its occurrence, including those focusing on biological disorders (Cataldo & Harris, 1982) and homeostatic processes through which SIB is seen as a reaction to either too little or too much environmental stimulation (Baumeister & Rollings, 1976; Guess & Carr, 1991).

Operant accounts of stereotypic SIB focus on potential maintaining consequences. In the absence of knowledge about specific maintaining variables, most investigators have assumed that the reinforcer maintaining stereotypic behavior is sensory in nature. For example, Lovaas, Newsom, and Hickman (1987) proposed a "perceptual reinforcement hypothesis" based on numerous observations of individuals with autism and developmental disabilities, whose repetitive behaviors (such as hand and finger waving, object spinning, etc.) apparently produced perceptual stimulation of a reinforcing nature. A more general maintaining contingency has been described as *automatic* reinforcement, which refers to a potentially broad array of stimulus changes

This research was supported in part by a grant from the Developmental Disabilities Planning Council and the Florida Department of Health and Rehabilitative Services. We thank Dorethea Lerman, Bridget Shore, and Richard Smith for their assistance with various aspects of research.

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(including both positive and negative reinforcement) that are directly produced by the behavior independent of social reinforcement (Iwata, Vollmer, & Zarcone, 1990).

Research on stereotypic behavior has produced two general approaches to treatment. One involves providing access to alternative sources of stimulation to compete with that produced by SIB. For example, in an early study on noninjurious stereotypic behavior, Berkson and Mason (1964) found that toy play and stereotypic behaviors were inversely related. When toys were available, subjects spent more time engaged in object manipulation and less time engaged in stereotypic behavior. Rincover, Cook, Peoples, and Packard (1979) demonstrated that individuals who engaged in stereotypic behavior could be taught to engage in toy play, which was associated with decreases in stereotypy. Favell, McGimsey, and Schell (1982) provided toys delivering stimulation similar to that apparently produced by the stereotypic behavior, and subsequently observed increases in toy play and decreases in stereotypy.

A second treatment approach, which comprises the focus of this study, is based on attempts to eliminate or attenuate the consequences directly produced by SIB, thereby producing extinction. Rincover (1978) introduced the term *sensory extinction* to describe this process and provided several examples applied to noninjurious stereotypic behavior. For 1 individual whose plate spinning on a table was thought to be maintained by auditory stimulation, the table top was carpeted to attenuate sound, and a decrease in plate spinning was observed. Vibrators were attached to the backs of 2 other individuals' hands for whom finger flipping (1 child) and object twirling (the other child) were hypothesized to be maintained by proprioceptive reinforcement. Decreases in stereotypy were observed for both individuals and were attributed to sensory extinction.

The procedures described by Rincover (1978) as sensory extinction and those used in subsequent studies actually involve two distinctly different types of operations. In some cases, the physical (as opposed to social) environment was altered in such a way that responses no longer produced the same effects. Rincover (1978) carpeted a table top to reduce sound produced by an individual's plate spinning; Rincover, Newsom, and Carr (1979) disconnected a light switch that 1 subject manipulated at high rates; and Rincover and Devany (1982) padded the walls and floor of a room to attenuate sensations produced by head banging. Because these examples involved manipulation only of the physical environment so that responding produced little or no stimulation (rather than increased stimulation, as would be the case with punishment), it seems reasonable to attribute behavior change to extinction processes.

In other studies, procedural implementation of sensory extinction involved placing various types of equipment on individuals such that the target behavior (usually SIB) could still occur, but its consequences were reduced or altered. The equipment was applied either at the beginning of the session (noncontingently) or following occurrences of the target behavior (contingently). Rincover (1978) demonstrated reductions in finger flipping in 1 individual and object twirling in another following noncontingent application of a vibrator to the backs of their hands. Dorsey, Iwata, Reid, and Davis (1982) demonstrated reductions in multiple topographies of SIB by using noncontingent application of a padded helmet and gloves. They also found that contingent application following an initial exposure to noncontingent application maintained decreases in SIB. Parrish, Iwata, Dorsey, Bunck, and Slifer (1985) also demonstrated that noncontingent application of a padded helmet and boxing gloves produced decreases in SIB that were maintained in a subsequent condition consisting of contingent application of equipment. Aiken and Salzberg (1984) used white noise delivered through headphones to alter feedback from loud vocalizations (1 subject) and hand clapping and dropping items (in another subject), and observed reductions in the target behaviors. In a recent investigation, Van Houten (1993) demonstrated that the noncontingent placement of soft wrist weights on an individual's forearms resulted in a decrease of self-injurious face slapping. Finally, Reid, Parsons, Phillips, and Green (1993) showed that self-injurious hand mouthing could be reduced by blocking the

subject's hand from entering the mouth (it was not clear from the description if the experimenter's hand was placed in front of the subject's mouth contingent on a hand-mouthing attempt, or if the experimenter's hand remained in place throughout the session).

Although noncontingent equipment, as described in the above examples, produces a change in stimulation when responding occurs, changes in stimulation also occur when responding is absent; it is possible that behavior reduction may be due to processes other than extinction. Simply wearing the equipment may function as aversive stimulation, resulting in generalized behavioral suppression (e.g., as in Dorsey et al., 1982; Parrish et al., 1985; Rincover, 1978; Van Houten, 1993). In the study by Reid et al. (1993), it is possible that the experimenter's hand was in front of the subject's face for much of the session, which also may have functioned as an aversive stimulus. Finally, in cases in which contingent equipment was used (e.g., Dorsey et al., 1982), the initial response necessarily produced unaltered stimulation. Thus, equipment placement was delayed and allowed some responses to be reinforced, both of which should have produced gradual reductions in responding. Some of the data presented by Dorsey et al. showed gradual decreases in SIB, but in other cases rapid response suppression, similar to that associated with punishment, was observed.

Because contingent protective equipment has been found to be effective in reducing some stereoptypic behaviors following exposure to noncontingent equipment, the effects of contingent protective equipment as an initial intervention should be examined. In two studies, Luiselli (1986, 1989) showed that contingent equipment may reduce SIB without prior exposure to noncontingent equipment. However, interpretation of the effects of intervention is difficult for two reasons. First, the contingent equipment was never applied as a single intervention in either study; that is, the procedure was superimposed on baselines consisting of differential reinforcement of other behavior (DRO) or differential reinforcement of alternative behavior (DRA). Thus, although the use of contingent equipment reduced SIB in both studies, it is not clear what effects contingent equipment would have had as a sole intervention. Second, neither investigation presented data indicating that the subjects' SIB persisted in the absence of social consequences. If SIB was maintained by social reinforcement, it is quite possible that treatment effects could be attributed at least in part to differential reinforcement and not only to the contingent equipment.

The aim of this study was twofold. The first was to establish that the SIB under investigation was not maintained by social sources of reinforcement. The second purpose was to replicate and extend previous research on sensory extinction by examining both noncontingent and contingent equipment when implemented as sole interventions.

METHOD

Subjects and Setting

Two women with profound mental retardation participated, based on referral for treatment of their chronic hand mouthing and the results of a functional analysis assessment indicating that their behavior was not maintained by social reinforcement. Both individuals lived in a public residential facility for persons with developmental disabilities. Marty was 33 years old, could walk independently, and was not aggressive or disruptive. She had limited self-help skills, no expressive language, and limited receptive language (e.g., she could follow simple instructions such as "Walk over here"). She received no psychotropic medication throughout the course of the study. Ava, a 34-year-old woman, was not aggressive and generally not disruptive. She had no expressive language, limited receptive language (she could follow simple instructions), and limited self-help skills. Ava was fully ambulatory and received no psychotropic medication throughout the course of the investigation. Both women engaged in chronic hand mouthing, which resulted in mild tissue damage. In addition to hand mouthing, Ava also engaged in tongue pulling that produced periodic irritation and ulcers.

Sessions were conducted at a day-treatment program located on the grounds of the facility. Treatment rooms were furnished with couches and chairs,

but other contents varied according to experimental conditions. Sessions lasted 15 min and usually were conducted 5 days per week, with two to four sessions daily.

Response Measurement and Reliability

Self-injurious behaviors were defined as follows: *hand mouthing*—insertion of the fingers, hands, or arm into the mouth past the plane of the upper and lower lips; *tongue pulling*—fingers grasping the tongue in a pulling motion away from the mouth. Because each individual's SIB was of a short duration, each occurrence of SIB was recorded, and session data were converted to responses per minute of SIB. At least one observer was present during each session and recorded data using a hand-held computer (Assistant Model A 102).

Interobserver agreement was assessed by having a second observer simultaneously but independently record data during at least 30% of all sessions. Interobserver agreement was calculated by dividing session time into consecutive 10-s intervals, and agreement percentages were based on interval-by-interval comparisons of the data. For each interval, the smaller number of observed responses was divided by the larger number of responses. These fractions were summed across all intervals and divided by the total number of intervals in the session. Mean agreement percentages for SIB were 97.1%, 94.6%, and 97.0% across subjects during assessment, baseline, and treatment sessions, respectively.

Experimental Sequence and Designs

Subjects were initially exposed to a series of assessment conditions to identify variables maintaining their SIB. A multielement design (Sidman, 1960; Ulman & Sulzer-Azaroff, 1975) was used for Marty's assessment, and a reversal design (Baer, Wolf, & Risley, 1968) was used for Ava's assessment. Following this assessment, baseline and treatment sessions were implemented in reversal designs. Because each subject experienced a somewhat different set of procedures, complete details are included in the description of their treatment conditions.

Functional Analysis Assessment

Subjects were exposed to four conditions based on procedures described by Iwata et al. (1982). A brief description of each is provided here.

Alone. Each subject was observed while she was alone in a room with no leisure materials available. This condition examined the extent to which SIB persisted in the absence of social consequences and other forms of environmental stimulation.

Attention. Leisure materials were available to the subject, and attention (e.g., "Stop, don't do that, you'll get hurt," with a brief touch to the shoulder or arm) was delivered contingent on each occurrence of SIB. This condition was designed to determine if SIB was sensitive to positive reinforcement in the form of adult attention.

Demand. The experimenter presented learning trials to the subject on a fixed-time (FT) 30-s schedule. Tasks used were similar to those found in the individual's educational plan. A three-prompt instructional sequence was used: The initial instruction was followed by a demonstration and, if necessary, physical guidance if compliance did not occur. Compliance was followed by praise, and SIB produced a 30-s time-out. This condition was designed to determine whether SIB was sensitive to negative reinforcement in the form of escape from instructional tasks.

Play. Leisure materials were available, the experimenter provided noncontingent attention on an FT 30-s schedule, and SIB produced no consequences. This condition served as a control.

Experimental Conditions

Following completion of the functional analysis assessment, the effects of noncontingent and contingent protective equipment were evaluated when implemented as sole interventions. The sequence for Marty replicated that used previously by Dorsey et al. (1982) and Parrish et al. (1985), in which a noncontingent-equipment condition preceded a contingent-equipment condition. By contrast, Ava was exposed to the contingent-equipment condition with no prior exposure to noncontingent equipment. Throughout baseline and both equipment

conditions, no social contingencies were implemented for either the occurrence or the absence of SIB, nor were any alternative (competing) activities available.

Baseline. This condition was identical to the alone condition of the functional analysis assessment, except that the experimenter was in the room with the subject (this was to control for experimenter presence during subsequent conditions). No leisure materials were present, and the experimenter did not interact with the subject at any time.

Noncontingent mitts. Oven mitts were placed on the subject's hands at the beginning of the session and remained on throughout the session. If the subject attempted to remove the mitts (this occurred infrequently), the mitts were reapplied by the experimenter. There were no other programmed contingencies, no interaction with the subject, and no leisure materials present in the therapy room.

Contingent mitts. The experimenter placed the mitts on the subject's hands contingent on the occurrence of SIB and left them in place for 30 s. Because the mitts did not restrict movement, it was possible for the subject to engage in SIB while wearing the mitts by placing the mitt in the mouth or touching the mitt to the tongue. If SIB occurred while a subject was wearing the mitts, they remained on for an additional 5 s for Marty and an additional 30 s for Ava. During this condition, the session timer was stopped when the mitts were placed on the hands and was restarted when the mitts were removed. SIB was counted only while the clock was running, and the session was terminated after 15 min had elapsed on the session clock. This procedure was followed so that data would reflect reponding during "time-in," when hand mouthing produced contact with the skin, rather than responding during "time-out," when mouthing may have been artificially suppressed by wearing the equipment. No toys or materials were present in the therapy room, and no interaction between experimenter and subject occurred except for mitt placement and removal.

Maintenance and follow-up. Following treatment, maintenance programs were developed for both subjects, and the staff members in their residences were taught to conduct daily treatment sessions. For both subjects, the maintenance program consisted of contingent mitts plus DRO. A 1-min DRO was added to the contingent-mitts procedure so that subjects would receive reinforcement for periods of time without SIB. The training procedure involved teaching a supervisor, who then trained direct-care staff. Upon completion of staff training, we periodically observed direct-care staff conducting the program in the subjects' residences during sessions of varying duration, using procedures as described under the contingent-mitts condition.

RESULTS

Results of the functional analysis assessment are shown in Figure 1. After 82 sessions for Marty, a cyclical pattern of responding persisted, with high and low rates of SIB covarying across conditions. Nevertheless, the highest rates of SIB usually occurred during alone sessions. Mean rates of SIB were, during alone, 4.1 responses per minute; demand, 3.0; attention, 2.5; and play, 2.2. Results for Ava showed SIB occurring in all assessment conditions, with the highest rates consistently occurring in the two alone conditions. Mean rates of SIB were, during alone, 12.0 responses per minute; demand, 7.5; attention, 2.2; and play, 4.1.

Results obtained during baseline, treatment, and follow-up conditions are shown in Figure 2. Results for Marty showed a variable but generally high rate of SIB during baseline (M = 8.2 responses per minute). An immediate decrease in SIB was seen when the noncontingent-mitts condition was implemented (M = 1.6), which was maintained during the subsequent contingent-mitts condition (M = 0.28). A brief return to baseline resulted in an abrupt increase in SIB to a mean of 17.1. When the contingent-mitts condition was reinstated, there was an immediate decrease in the rate of SIB to a mean of 0.63.

Results for Ava showed a variable and high rate of SIB during the initial baseline (M = 16.1 responses per minute). Implementation of the contingent-mitts condition resulted in a rapid decrease

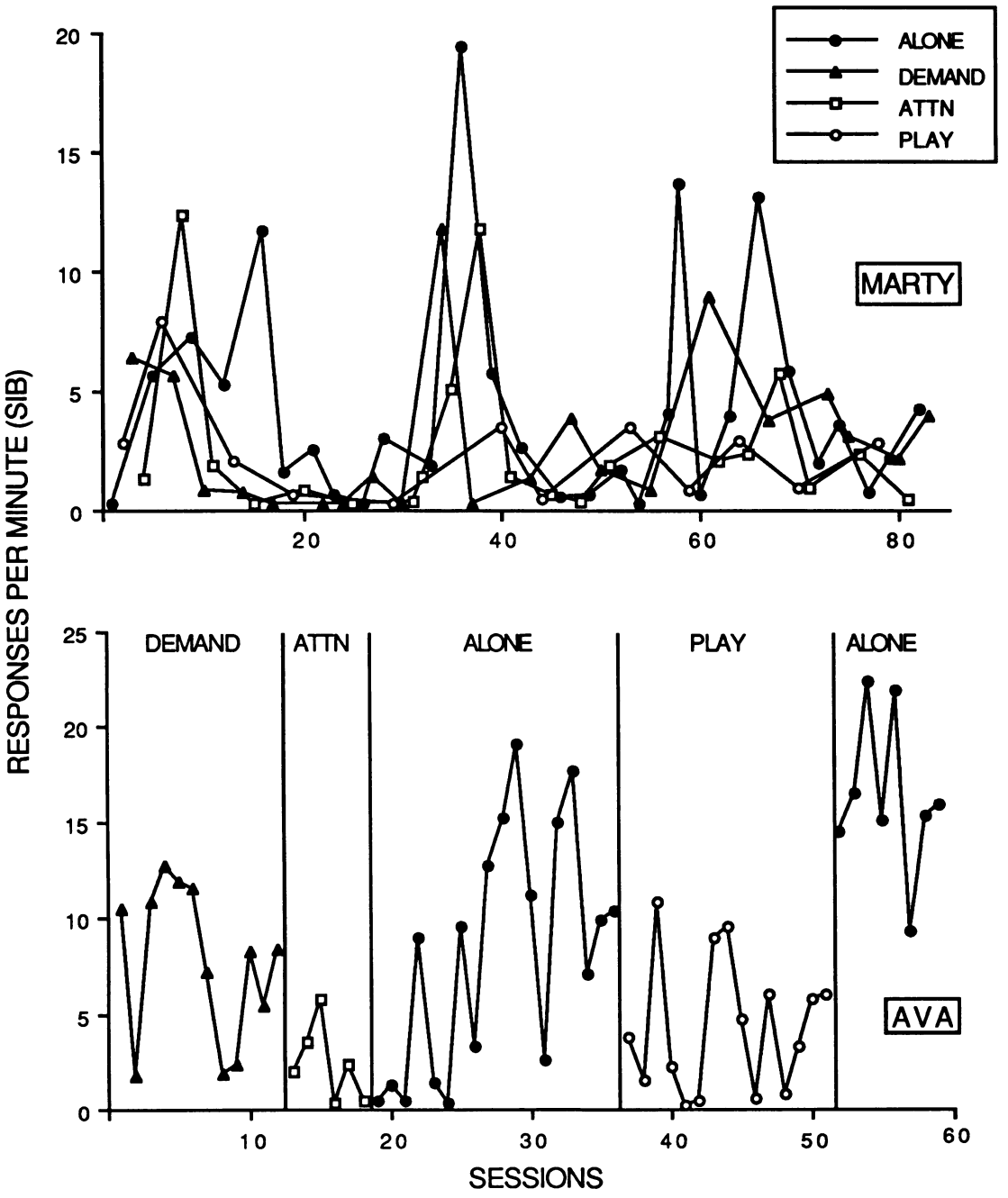

Figure 1. Responses per minute of SIB for Marty (upper panel) and Ava (lower panel) during their functional analysis assessments.

in SIB (M = 1.3). Following a brief return to baseline, during which SIB increased to a mean rate of 10.7, the contingent-mitts condition was reinstated and resulted in a decreased rate of SIB (M = 1.9), similar to that observed in the initial application.

Follow-up. For Marty, formal follow-up observations were conducted on the 1st day after staff

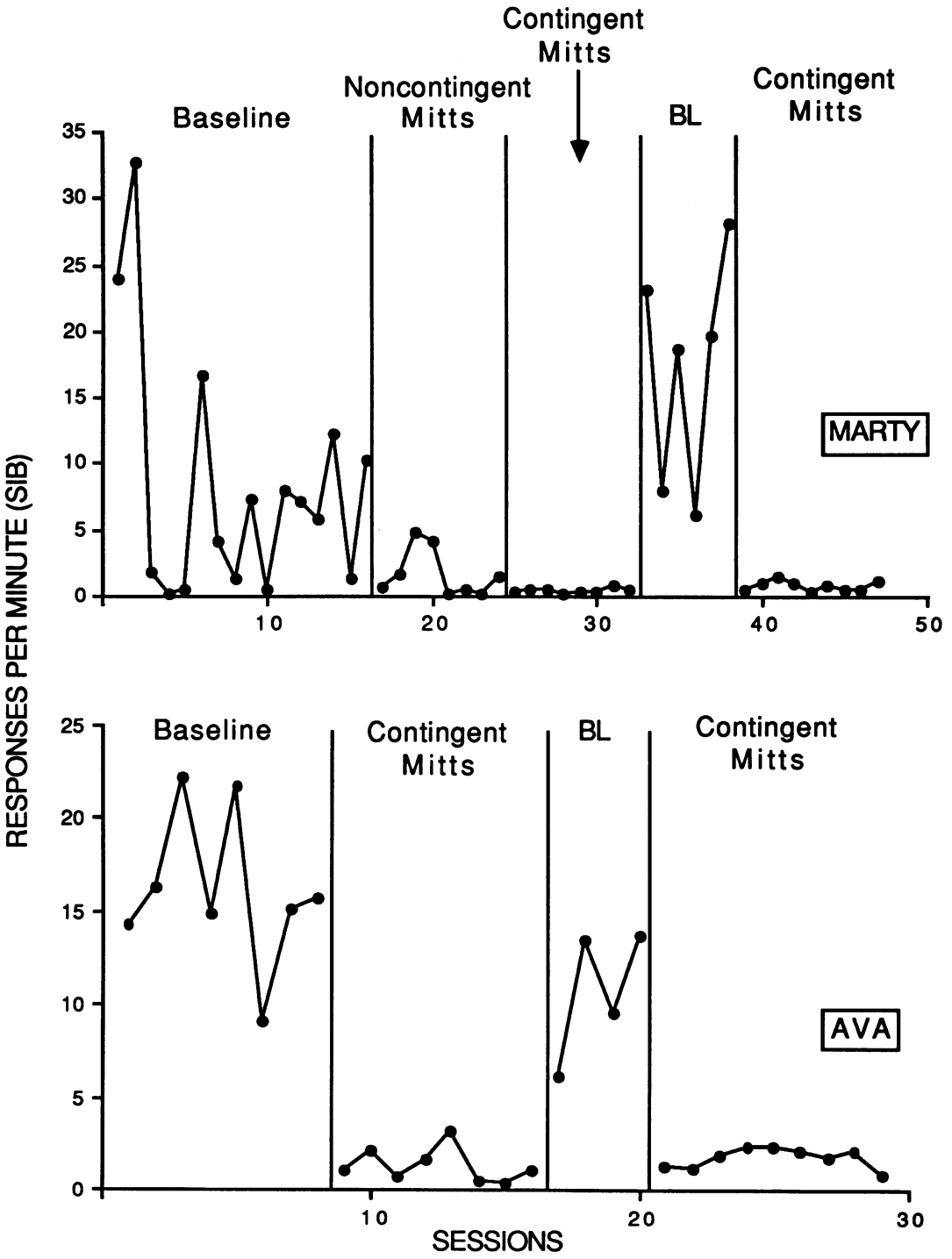

Figure 2. Responses per minute of SIB for Marty (upper panel) and Ava (lower panel) during baseline, treatment, and follow-up conditions.

training and again 4 months later. Rates of SIB were 0.6 and 0.0 responses per minute for the 1-day and 4-month follow-ups, respectively. For Ava, follow-up observations were conducted on the 2nd day after staff training and again 2 months later. Rates of SIB were 0.13 and 0.21 for the 2-day and 1-month follow-ups, respectively. Although no quantitative measures were taken on the amount of tissue damage to each individual's hands, neither subject showed any evidence of chapping or skin abrasion by the end of treatment or during follow-up observations.

DISCUSSION

Based on the results of a functional analysis assessment, which showed that neither subject's SIB was sensitive to social consequences, two treatment approaches were evaluated. The effects of noncontingent protective equipment followed by contingent equipment were examined with Marty. Contingent equipment, with no prior exposure to noncontingent equipment, was used with Ava. Both procedures were implemented in the absence of other treatment components, and both produced immediate and large reductions in SIB that were maintained over time. In addition to having practical significance, these results raise several questions about the assessment of SIB that is not maintained by social reinforcement and about the interpretation of effects for procedures, often described as sensory extinction, used in treating such behavior.

With respect to assessment, the identification of social sources of reinforcement for behaviors such as SIB is relatively straightforward from a methodological standpoint. Attention (positive reinforcement) or escape (negative reinforcement) contingencies usually are not difficult to arrange, and their effects on behavior can be observed when good control is exerted over the independent variable. The influence of nonsocial (automatic) reinforcement is more difficult to identify, because the reinforcing stimuli are directly produced by the response. Thus, it is not often easy to arrange conditions under which the experimenter can control the delivery of reinforcement independent of the subject's behavior (Rincover et al., 1979, arranged such a condition by disconnecting a light switch so that flipping it did not produce light). Instead, a conclusion that SIB (or other forms of stereotypic behavior) is maintained by directly produced consequences is usually based on two sources of data: (a) a salient stimulus change produced by the response (for which SIB qualifies), and (b) a lack of behavioral sensitivity to social sources of reinforcement. This latter criterion can be met when several patterns of responding are observed during the course of a functional analysis assessment. First, if alternative activities are available and if they compete with (substitute for) SIB, relatively lower levels of SIB would be observed when these activities are present than when they are absent. That is, if the programmed activities included in attention, demand, and play conditions competed with SIB, high rates of SIB would be observed only in the alone condition. Second, if alternative activities only partially competed with SIB, SIB would be observed in all assessment conditions, but higher rates would occur in the alone condition. Finally, if none of the activities competed with SIB, undifferentiated rates of SIB would be observed across all assessment conditions.

The assessment data for Ava were consistent with the second pattern described above. Her SIB occurred during all assessment conditions, but noticeably higher rates were observed during the alone conditions. Marty's SIB during assessment most closely resembled the third pattern (undifferentiated responding), although SIB occurred somewhat more often during the alone condition. However, the apparent cyclical nature of her responding, in which low rates of SIB were observed for a number of sessions (regardless of condition), followed by high rates, is more difficult to explain. It is quite possible that some unknown and therefore uncontrolled variable affected her behavior; therefore, the conclusion that her SIB was maintained solely by its sensory consequences must be offered tentatively. Nevertheless, the fact that neither subject's SIB was sensitive to social reinforcement is consistent with data from other studies in which the authors concluded that SIB was maintained by automatic re-

inforcement (e.g., Iwata, Pace, Cowdery, & Miltenberger, 1994; Lerman & Iwata, 1993; Mason & Iwata, 1990; Reid et al., 1993; Van Houten, 1993).

Results obtained during treatment raise other questions about the behavioral mechanism(s) responsible for observed reductions in hand mouthing. Results of the noncontingent-mitts condition with Marty replicated previous findings reported by Dorsey et al. (1982) and Parrish et al. (1985), who demonstrated reductions in SIB through the use of continuous protective equipment. However, several mechanisms may have been responsible for the behavioral reduction observed with both Marty and the subjects in previous studies. First, because responding could still occur, although its sensory consequences were attenuated, the application of noncontingent mitts could be viewed as a sensory extinction procedure. A second possibility is that wearing the equipment may have served as aversive stimulation or produced time-out from a variety of sources of stimulation.

The contingent mitts used with Marty also produced consistently low rates of SIB, and Ava's results showed that although she had no history with noncontingent mitts, contingent mitts produced large reductions in SIB. These results cannot be attributed to the influence of other therapeutic procedures (such as differential reinforcement) that were not implemented during initial treatment conditions. It also is highly unlikely that behavior reduction was a function of extinction. Because the mitts were on the subjects' hands for only brief intervals, and because SIB was counted only when the mitts were not worn, there were ample opportunities to engage in hand mouthing that involved direct contact of the skin. Some unattenuated responses could and did occur during the contingent-equipment conditions, which functionally amounted to intermittent reinforcement that would have disrupted the course of extinction. It is, of course, possible that the reinforcer for hand mouthing was not brief but extended access to stimulation, in which case any interruption in responding (e.g., brief placement of mitts on the hands contingent on hand mouthing) might have produced extinction. However, the fact that both subjects typically engaged in hand mouthing for very brief amounts of time (mean response duration for both subjects was less than 5 s) suggested that brief contact between hand and mouth maintained responding. Because hand mouthing was not maintained when brief access to reinforcement was available during the contingent-mitts condition, extinction effects seem unlikely for these subjects.

One explanation for the reductions seen in Marty's SIB during the contingent-mitts condition involves a transfer of control from the previous noncontingent-mitts condition. This explanation, however, could not account for Ava's results, because she never experienced the noncontingent application of mitts. Thus, data from the contingent-mitts conditions lend further support for a punishment or time-out interpretation. Because the mitts were presented contingent on the occurrence of SIB, the contingent mitts may have functioned as contingent aversive stimulation. The mitts may also have served as time-out, because access to reinforcement was removed when the mitts were in place; therefore, the individual could not obtain reinforcement from hand mouthing or other sources. The distinction between these processes may be arbitrary and difficult to isolate; thus, both interpretations are offered as an alternative to sensory extinction.

Finally, it is conceivable that the behavioral reduction observed in our subjects represents two distinct processes. That is, suppression resulting from wearing equipment noncontingently may be due to extinction, whereas the same results obtained when equipment is applied contingently may reflect the outcome of punishment or time-out.

Our interpretation of the effects of contingent equipment must be considered to be tentative, because manipulations necessary to differentiate punishment or time-out effects from those of extinction were not undertaken. One such manipulation would involve the use of protective equipment contingent on two responses maintained by two different reinforcers. For example, one response might consist of hand mouthing or a similar stereotypic behavior that is maintained independent of social conse-

quences (i.e., by sensory reinforcement), whereas the second response would be an arbitrary topography (e.g., button pressing) that is maintained by delivery of praise or food. If contingent equipment that did not interfere with responding suppressed both behaviors while baseline contingencies remained in effect (i.e., no social consequences for hand mouthing and continued delivery of praise or food for button pressing), clear demonstration of a punishment effect for button pressing would be provided, thus strengthening the conclusion that the equipment per se was an aversive event. If contingent equipment reduced hand mouthing but not button pressing, the absence of an observed punishment effect with button pressing would favor an alternative explanation (perhaps extinction) for reductions in hand mouthing.

In a recent analysis of procedural and functional variations of extinction, Iwata et al. (1994) provided an approximation to the above paradigm. They evaluated three different extinction procedures as treatment for head banging that was maintained by three different reinforcement contingencies. For 2 subjects whose behavior was maintained by social consequences—attention and escape—effective extinction consisted of discontinuing attention or continuing demands, respectively, contingent on SIB. Both subjects were also exposed to a sensory extinction procedure—noncontingent placement of a padded helmet on each individual's head at the beginning of the session. Little or no suppression of SIB was observed during the sensory extinction condition. For the 3rd subject, whose SIB was not maintained by social reinforcement, reductions in SIB were observed only during the sensory extinction condition. These results suggest that (a) the wearing of equipment per se is not necessarily a punishing event, and (b) *noncontingent* equipment may produce extinction under some conditions; however, the results do not clarify the mechanism(s) underlying the use of *contingent* equipment.

Another approach to examining the function of protective equipment would make use of an apparatus that could be modified to provide different degrees of attenuation. For example, an inflatable helmet could be used either noncontingently or contingently as treatment for head banging. The inflatable helmet would control for weight differences, so that minimal weight would be added as response attenuation is increased during inflation. If reductions in head banging were observed when the helmet was both minimally and maximally inflated, effects could be due to either extinction or punishment. If head banging decreased only when the helmet was maximally inflated, behavior change could not be attributed to the equipment per se (i.e., punishment) but, rather, to the greater attenuation of stimulation resulting from inflation.

The above strategies represent complex undertakings, and none is definitive; that is, alternative explanations are still possible. This fact illustrates the difficulty in identifying the function of behavior-change procedures when the consequences of responding are tenuous and perhaps poorly controlled. Nevertheless, future research along the lines suggested would help to clarify the manner in which treatments based on the use of protective equipment can best be implemented and their effects extended. Although previous investigators (e.g., Dorsey et al., 1982; Iwata et al., 1994) have speculated that some procedures described as sensory extinction may actually illustrate other behavioral mechanisms such as punishment, few have proposed methods to disentangle these processes. Suggestions for future research described here are proposed not only to encourage more analytic research on behavioral mechanism but also to discourage perpetuation of the use of a common but currently unsupported "sensory extinction" explanation for reductions in problem behaviors that are obtained with protective equipment.

Regardless of function, the finding that contingent protective equipment as a single intervention was effective in reducing chronic hand mouthing represents a distinct advantage over the use of noncontingent equipment. Contingent equipment that maintains low levels of behavior when the apparatus is not worn provides an individual greater freedom to participate in alternative activities. To the extent that these activities strengthen other behaviors that lead to contact with new reinforcers, these consequences may eventually compete with

those maintaining SIB and perhaps other behaviors whose reinforcers are a direct product of responding.

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Received July 6, 1993
Initial editorial decision August 31, 1993
Revisions received January 6, 1994; February 7, 1994; February 14, 1994
Final acceptance February 14, 1994
Action Editor, Robert H. Horner