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STIMULUS FADING AND TRANSFER IN THE TREATMENT OF SELF-RESTRAINT AND SELF-INJURIOUS BEHAVIOR

GARY M. PACE, BRIAN A. IWATA, GLYNNIS L. EDWARDS, AND KAY C. MCCOSH

THE KENNEDY INSTITUTE AND THE JOHNS HOPKINS UNIVERSITY SCHOOL OF MEDICINE

We conducted several manipulations of mechanical restraint properties during the course of treatment for two profoundly retarded adolescents who exhibited both self-restraint and self-injurious behavior. In study 1, a combination of prompting, differential reinforcement, and stimulus fading reduced one subject's self-restraint, which consisted of holding rigid tubes on his arms. Subsequently, stimulus control of both self-restraint and self-injurious behavior was transferred to tennis wrist bands. In study 2, a second subject's self-restraint—placing his hands in his pants—was immediately eliminated by the use of air splints. Additionally, differential reinforcement and air-pressure fading resulted in the complete mobility of his arms and a substantial increase in appropriate behaviors. Results of this investigation suggest that stimulus fading and transfer may be valuable components in the elimination of self-restraint.

DESCRIPTORS: self-restraint, restraint fading, self-injurious behavior, stimulus control, retarded individuals

Self-injurious behavior (SIB) refers to behavior that results in physical injury to the individual's own body (Tate & Baroff, 1966). In general, self-injury is chronic and repetitious, occurring at frequencies ranging from several times per week to hundreds of times per hour over a sustained period of time. Although self-injury occurs in normally developing children (deLissovoy, 1961; Kravitz & Boehm, 1971), the prevalence and severity are generally greater among the developmentally disabled (Green, 1967; Maisto, Baumeister, & Maisto, 1978; Schroeder, Schroeder, Smith, & Dalldorf, 1978).

In an effort to prevent permanent disabilities that might result from chronic SIB, many children are required to wear restraint devices (Paul & Romanczyk, 1973). The most commonly used restraints include rigid arm splints, camisoles, fencing masks, helmets, and wrist and/or leg ties. Although it is generally agreed that such devices are sometimes necessary to provide immediate protection, their persistent use has been associated with several risks. Because protective devices generally immobilize the injurious limb, their prolonged use may result in demineralization of bones, shortening of tendons, and/or arrested motor development (Lovaas & Simmons, 1969). Additionally, physical restraints may reduce the frequency of social interactions between the person restrained and his or her caretakers (Rojahn, Mulick, & Schroeder, 1980), and may interfere with adaptive behaviors (Favell, McGimsey, Jones, & Cannon, 1981).

Several investigators have reported that some self-injurious individuals appear to enjoy their physical restraints (Frieden, 1977; Jones, Simmons, & Frankel, 1974; Myers & Deibert, 1971; Tate, 1972). In fact, Favell and her colleagues (Favell, McGimsey, & Jones, 1978; Favell et al., 1981) have demonstrated that the opportunity to self-restrain can function as a reinforcer. In some individuals, self-restraint can be so potent a reinforcer that it becomes the predominant behavior, with restraint removal being actively resisted. In such cases, access to physical restraints contingent on increasingly longer periods of noninjury has been

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Reprints may be obtained from Gary M. Pace, Center for the Study and Treatment of Self-Injury, The Kennedy Institute, 707 N. Broadway, Baltimore, Maryland 21205.

shown to result in reductions in both self-injury and time in restraints (Favell et al., 1978; Foxx & Dufrense, 1984).

Despite the contributions of the above research, self-restraint remains a relatively understudied phenomenon. In this investigation we examined several properties of restraints, restraint fading, and stimulus control in two individuals who exhibited both self-restraint and SIB. Both studies 1 and 2 represent systematic attempts to eliminate or reduce self-restraint while maintaining low rates of SIB, using a combination of restraint fading and differential reinforcement.

STUDY 1

METHOD

Subject and Setting

Jack was an 18-year-old profoundly retarded male with fetal alcohol syndrome, who had been institutionalized since 3 years of age. At the time of admission, his SIB consisted of hand, biceps, and shoulder biting, and hand and leg scratching, which began when Jack was 9 years old.

During the previous 9 years, several unsuccessful attempts to reduce Jack's self-injury were undertaken, including medications, behavioral treatment (e.g., differential reinforcement of incompatible behavior, extinction), and various forms of protective equipment such as wrist restraints tied to a belt, a large collar worn around the neck and extending out beyond the shoulders, a helmet with a clear plastic face guard, and 47-cm rigid tubes that extended from the shoulders to the hands and were held in place by Jack. These tubes made arm flexion and hand biting impossible. At the time of his admission to the hospital, Jack was self-restraining in rigid tubes 24 hours a day.

Sessions were conducted in two settings: an individual therapy room (3 m^2) equipped with a one-way observation window and a group therapy room (15 m × 8 m). Both rooms contained tables and chairs, toys, and other educational materials. Three to seven patients and two or three staff members were present in the group environment at any given time.

Observation Procedures and Interobserver Agreement

SIB was scored whenever Jack's teeth were in contact with his hands, arms, or shoulders, or whenever he scratched his hands or legs. Self-restraint was defined as physical contact with at least one restraint. During each session, an observer recorded the occurrence or nonoccurrence of SIB and self-restraint during continuous, 10-s intervals (Powell, Martindale, & Kulp, 1975), which were signaled by a cassette tape. The percentages of intervals of self-injury and self-restraint were calculated individually by dividing the number of positively scored intervals by the total number of intervals and multiplying by 100 (Bailey & Bostow, 1979).

Interobserver agreement was assessed during 40% of the sessions across all conditions. Overall, occurrence, and nonoccurrence agreement were calculated on an interval-by-interval basis by dividing the number of agreements by the number of agreements plus disagreements and multiplying by 100. Mean agreement for SIB was 98% overall, 74% for occurrence, and 98% for nonoccurrence. Mean agreement for self-restraint was 99% overall, 88% for occurrence, and 82% for nonoccurrence.

Procedure

One to eight sessions were conducted daily. These sessions were designed to sample behavior throughout the day in both individual and group settings. All individual sessions were 15 min in duration, whereas group sessions varied from 5 to 15 min. However, any session could be terminated sooner if Jack's behavior reached a predetermined criterion. The termination criterion was established by a pediatrician at Jack's admission and documented the degree of injury or the nature of the responses that would require the immediate termination of a session. Jack's behavior attained the termination criterion during two sessions (see probe sessions).

Baseline. The experimenter periodically presented toys to Jack, allowing him to engage in isolated or cooperative toy play or to move freely

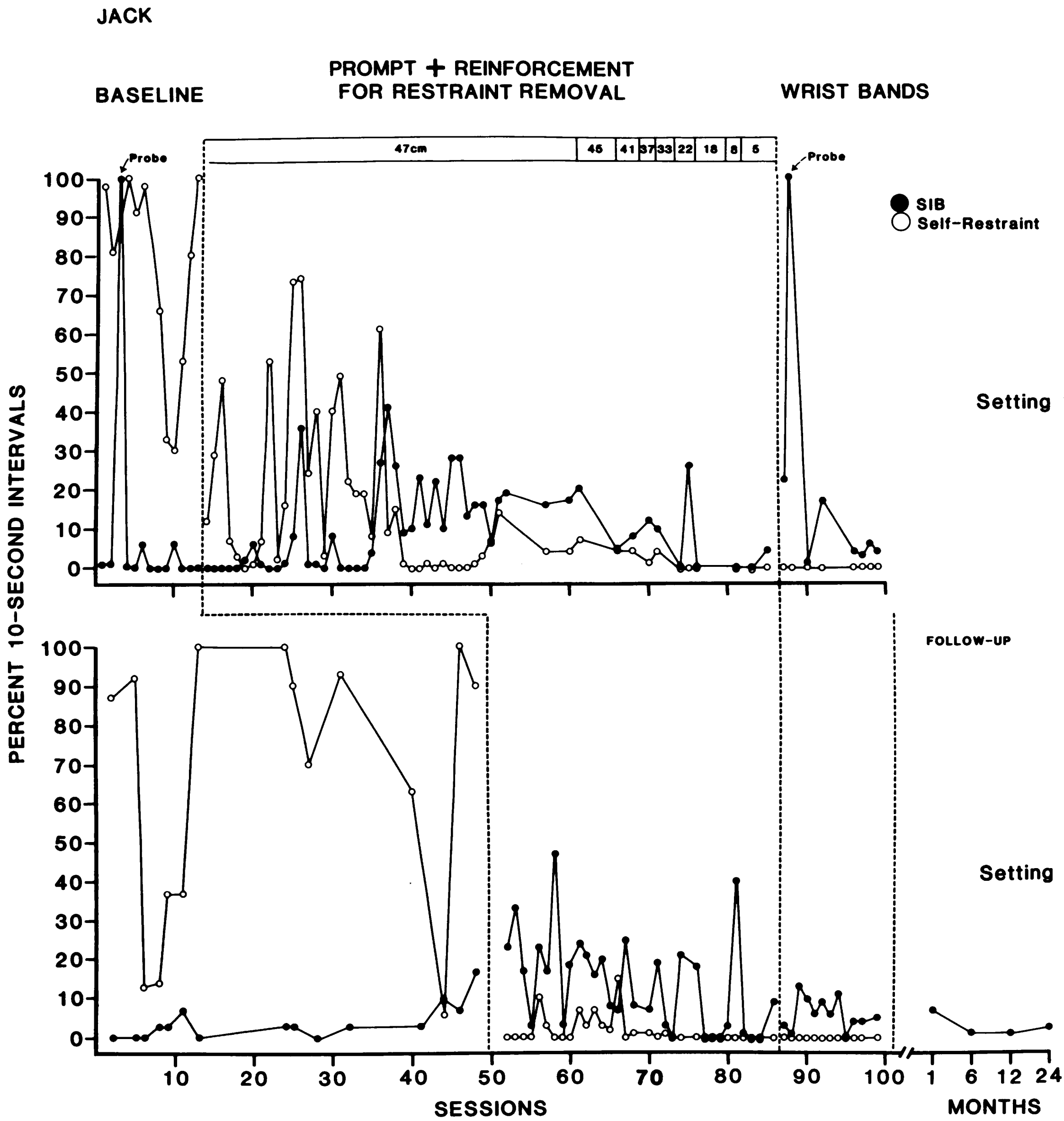

Figure 1. Percent intervals of SIB and self-restraint for Jack during baseline and treatment conditions across individual and group settings. Numbers across the top of the upper panel correspond to the length of Jack's arm restraints.

about the room. All instances of SIB were ignored and praise and physical contact were provided contingent upon toy contact (Iwata, Dorsey, Slifer, Bauman, & Richman, 1982). In an attempt to encourage Jack to remove his restraints, toys were chosen that required arm movement (e.g., a push button music box, a ball, stacking blocks).

Prompt plus reinforcement for restraint removal. As in baseline, Jack was placed in a play condition with an experimenter. However, in this condition, the experimenter either prompted the removal of the restraints or provided praise and physical contact contingent upon the absence of restraints approximately once every 60 s.

Prompt reinforcement for restraint removal, and restraint fading. Jack's restraints were reduced in length from 47 to 5 cm in a series of eight steps over a period of 22 days. No specific rules were used to determine the length reduction at each step or the criteria for moving from one step to the next. As in the previous condition, Jack was prompted to remove his restraints, and reinforcement was provided for the absence of restraint and SIB. However, when Jack's restraints were reduced to 5 cm in length, they no longer restricted movement and he was no longer requested to remove them. Over the next several sessions, the 5-cm cuffs were covered with fabric and then faded to tennis wrist bands.

Probe sessions. Two probes, one during baseline and one during restraint fading, were conducted while the rigid tubes or wrist bands were not available. Each session was terminated within 2 min because Jack's behavior met the predetermined termination criterion.

Follow-up. These sessions were conducted in the individual treatment room at 1, 6, 12, and 24 months following discharge. During these sessions, Jack continued to wear the wrist bands, and toy contact and the absence of self-injurious behavior were reinforced.

A multiple baseline across settings design (Baer, Wolf, & Risley, 1968) was used to evaluate the effects of the experimental conditions.

Results and Discussion

Figure 1 shows a somewhat inverse relation between Jack's self-restraint and his SIB during baseline. When given the opportunity to restrain, Jack engaged in high but variable amounts of self-restraint and low amounts of SIB; when restraints were not available (probe), SIB occurred during 100% of the intervals.

Upon the introduction of the prompt and differential reinforcement procedures, self-restraint decreased to near zero levels within 25 sessions in the individual setting and immediately in the group setting. These decreases in self-restraint, however, were associated with increases in SIB. The addition of restraint fading to the prompt and differential reinforcement did not result in a further increase in self-injury. In fact, the data in Figure 1 reveal that SIB was reduced to near baseline levels following the introduction of the wrist bands. The immediate increase in self-injury when the bands were removed (second probe) suggests that the wrist bands had acquired stimulus control over SIB. This transfer of control from restrictive to symbolic restraint was also reported by Foxx and Dufrense (1984). They successfully faded the size of held objects and substituted eyeglasses as an appropriate restraint for a self-injurious client who found self-restraint reinforcing.

Perhaps the most significant finding was that the SIB remained at low levels and Jack remained restraint-free for 2 years following discharge (Figure 1). The absence of restraints allowed Jack to qualify for a new educational placement, where he has acquired a number of self-help and academic skills. During this period, Jack continued to wear the wrist bands 24 hours a day.

These data demonstrate how a combination of differential reinforcement and restraint fading can result in the elimination of rigid restraints, while maintaining low levels of SIB. Jack's fading procedure was gradual in that only a few centimeters of the restraints were cut at any given time. Quite possibly, though, the ability of the restraints to prevent or interfere with self-injury may not have been a gradual process. That is, as long as the tubes covered the elbow, they prevented SIB; however, immediately upon falling below the elbow, they allowed complete mobility of the arms. In a sense then, this procedure may have involved only one fading step—elbow covered to elbow free.

In Jack's case it was not clear when this critical point occurred. When his restraints were too short to cover his elbows, he pulled them up and bent his arms so that they remained over the elbows, thereby preventing arm flexion. As the restraints were cut down further, it required more effort to keep them over the elbows and Jack occasionally would allow them to fall to his wrists. Over a 3- or 4-day period, Jack's restraints began to be down more than up. At this point (when the restraints were 5 cm), the restraints were narrowed so that he could no longer pull them up over his elbows. Jack spent a few days pulling the splints as far up on his forearms as possible and then allowed them to rest at his wrists. Once the restraints were faded to cloth wrist bands, Jack was never observed to pull the elastic bands up over his elbows.

STUDY 2

The rigid tubes that Jack used to self-restrain readily lent themselves to physical fading through a gradual reduction in length. However, restraint fading is generally not considered when an individual's self-restraint involves a device that cannot be gradually reduced in size. For example, many self-injurious clients restrain by wrapping their arms in clothing, placing their hands in pockets, sitting on their hands, or holding their hands together (Silverman, Watanabe, Marshall, & Baer, 1984). In these cases, it may be possible to transfer control to an alternative mode of restraint that can more easily be faded.

A restraint device that has been successfully faded in self-injurious individuals who do not self-restrain is the pneumatic air splint (Allen & Harris, 1966; Ball, Campbell, & Barkemeyer, 1980; Paul & Romanczyk, 1973). An advantage of air splints over rigid restraints is that, although the latter can only be faded along one dimension (length), the former can be faded across two dimensions (air pressure and length). Furthermore, the pressure in the pneumatic splints can be adjusted to provide an almost infinite number of fading steps from complete limb immobilization to free movement.

In study 2 we attempted to transfer control from a form of self-restraint that could not be easily faded to the pneumatic air splints. We then attempted to reduce the restraints by fading the air from the pneumatic device.

The effect of air splints on self-injury, self-restraint, and toy contact were evaluated using a multiple baseline across settings design.

Method

Subject and Setting

Bart was a 15-year-old profoundly retarded male with Down syndrome and recurrent middle ear infections, who had been institutionalized since the first week of life. His SIB, which consisted of vigorously scratching the skin behind each ear, was reported to have begun when he was less than 1 year old. Bart had been reported to engage in several forms of self-restraint, including putting his hands in his pockets, inside his pants, under his thighs, and behind his back. At the time of admission, Bart was restrained in rigid elbow splints that prevented arm flexion.

The settings were the same as those reported in study 1.

Apparatus

The pneumatic splints were 38 cm × 17 cm at deflation and were covered with a protective nylon mesh. They extended from Bart's shoulders to his wrists. The splints were inflated with a rubber blood pressure bulb, and air pressure was monitored with a sphygmomanometer (Ball et al., 1980). All measures of air pressure were taken with the arms at full extension.

Observation Procedures and Interobserver Agreement

SIB was scored whenever Bart's hands were in contact with his ears. Self-restraint was defined as at least one hand in his pants. Toy contact was defined as at least one hand in contact with a toy. Measurement was the same as that used in study 1.

Interobserver agreement was assessed on self-injury, self-restraint, and toy contact during 57% of the sessions. Overall, occurrence, and nonoccurrence agreement scores were calculated on an interval-by-interval basis as described in study 1. All agreement scores for self-injury and self-restraint were 100%; agreement for toy contact was 94% overall, 85% for occurrence, and 71% for nonoccurrence.

Procedure

One to eight sessions were conducted daily. All sessions, individual or group, were 15 min long. Although a specific termination criterion was established (see study 1), Bart's SIB never attained it and therefore no sessions were terminated prematurely.

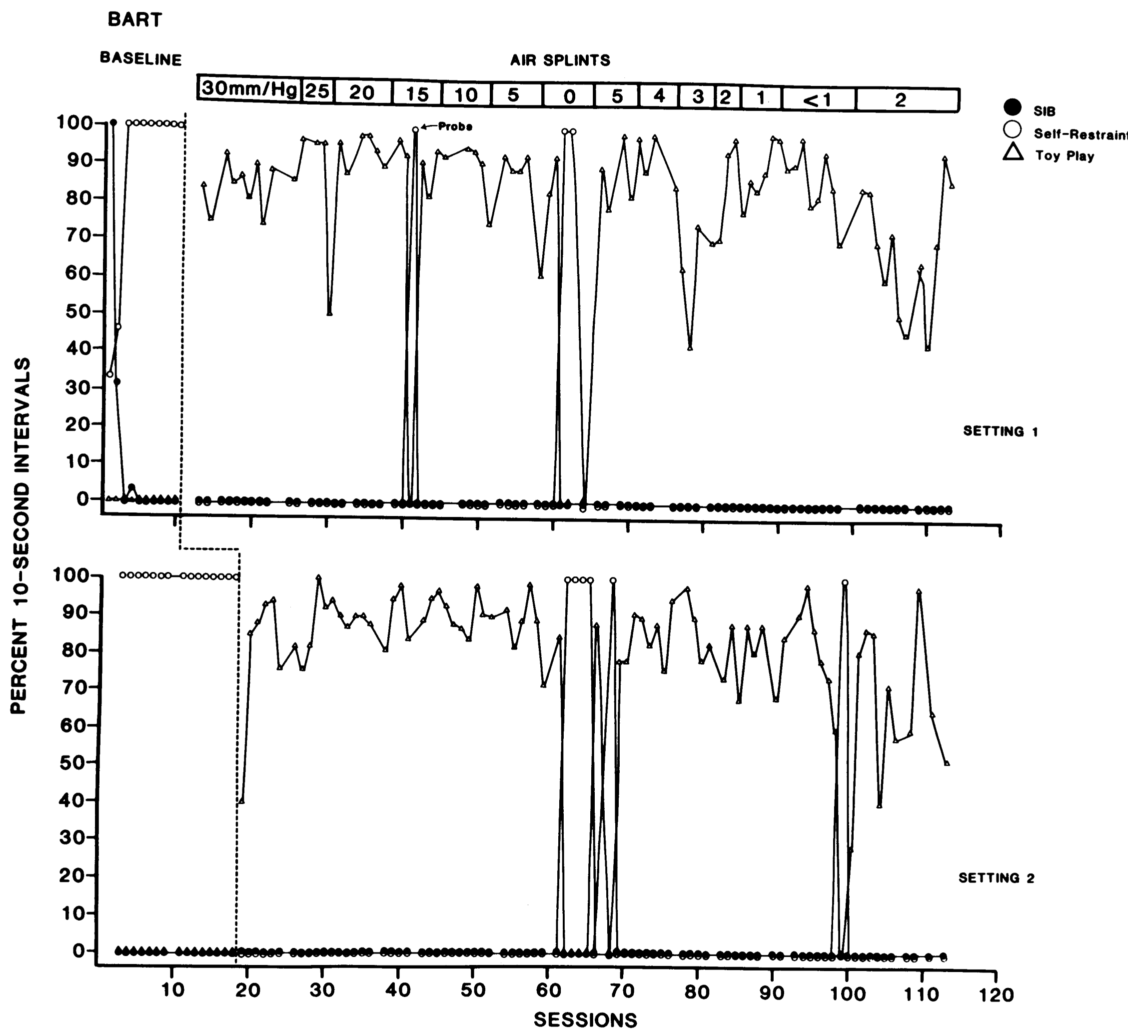

Figure 2. Percent intervals of SIB, self-restraint, and toy contact for Bart during baseline and treatment conditions. Numbers across the top of the upper panel correspond to the resting pressure in Bart's air splints.

Baseline. Bart's rigid elbow splints were removed for all baseline sessions. As in study 1, the experimenter maintained close proximity to Bart and allowed him to engage in toy contact or to move freely about the room. Praise and physical contact were scheduled to be provided contingent upon toy contact. All instances of SIB were ignored.

Air splint fading. Bart was restrained in air splints at 30 mm/Hg, which prevented arm flexion. The air pressure of the splints was gradually reduced (in 5 mm/Hg increments) from 30 to 0 mm/Hg in six steps over a period of 63 days. As in baseline, praise and physical contact were provided contingent upon toy contact, and all instances of SIB were ignored.

Probe session. One probe was conducted during air splint fading in which the splints were removed. All other aspects of the air splint fading condition remained unchanged.

Results and Discussion

Figure 2 shows that the removal of the rigid restraints (baseline) initially resulted in a high level of SIB, followed by continuous self-restraint with no toy contact or SIB. The introduction of the air splints resulted in an immediate elimination of self-restraint and a concomitant increase in toy contact in both settings. No SIB was observed during any of the air splint sessions. Self-restraint and self-injury remained at zero throughout the first five fading steps. When the air pressure was reduced to 0 mm/Hg, Bart began to self-restrain and subsequently ceased to engage in toy play. Although no SIB was observed in the formal sessions, low levels were reported throughout the day while Bart's splints were at 0 mm/Hg. When the splints were reinflated to 5 mm/Hg, Bart's self-restraint immediately decreased and his toy play increased in both settings. In five subsequent steps, Bart's splints were faded to less than 1 mm/Hg. Periodic SIB and self-restraint were again observed outside the sessions and the splints were inflated to 2 mm/Hg prior to discharge.

It is noteworthy that we were able to transfer control from one form of restraint to another. During baseline, Bart kept his hands in his pants almost constantly. However, once the air splints were introduced, he immediately took his hands out of his pants, although it was possible for him to self-restrain when the splints were fully inflated. When the splints were removed (probe) he engaged in his previous form of restraint. This finding suggests that in those cases where self-restraint does not immediately lend itself to fading, the topography of self-restraint may be modified to one that can be more easily faded.

We attempted to determine objectively (i.e., with a goniometer) the degree of arm flexion and the behaviors that were possible at each level of inflation. However, due to Bart's general reluctance to bend his arms, we were unable to obtain these measures. Nevertheless, at discharge Bart seemed to enjoy virtually complete mobility of his arms and was engaging in several self-help behaviors for the first time in his life. For example, at 5 mm/Hg Bart began eating independently for the first time and would occasionally touch the top of his head. Clearly, Bart could scratch his ears at these pressures, but he rarely did.

Our postdischarge plan was to continue to fade Bart's splints to 0 mm/Hg and then to begin to fade their length (as in study 1) on an outpatient basis. Following discharge, the staff at Bart's institution continued to use the air splints at 2 mm/Hg and the differential reinforcement procedure. However, they encountered several problems with the pneumatic devices (e.g., leaks, misplacement of the inflation apparatus) and, within a few weeks, decided to return Bart to the rigid restraints he wore prior to admission to our program. Subsequently, the staff implemented a fading procedure whereby they gradually bent and shortened the rigid restraints. Bart's restraints have been bent from 180 degrees to approximately 115 degrees. Although SIB and self-restraint are possible, they are reported to be occurring at low rates.

GENERAL DISCUSSION

The combined use of restraint fading and differential reinforcement eliminated self-restraint and maintained SIB at very low levels in two severely self-injurious individuals who engaged in high levels of self-restraint. Jack's restraints were faded from restrictive tubes held over the arms to elastic wrist bands that permitted complete mobility. Bart's self-restraint (placing his hands in his pants) was transferred to an alternative restraint, air splints, which were successfully faded from a pressure that prevented arm flexion to one that provided no observable resistance to arm movement.

The present data suggest that when choosing protective equipment for a self-injurious client, one should consider a restraint that may be systematically eliminated. The pneumatic devices are a logical choice for individuals who engage in head or face hitting because the air pressure can be easily monitored and gradually decreased to allow full mobility. The air splints are not without disadvantages, however. Bart's splints developed numerous leaks, necessitating frequent checks of the devices and a large supply of pneumatic restraints. It is not clear what effect these problems had on the present data, but it is likely that restraint fading would have been more rapid and perhaps more complete if reliable devices were used. (We have recently obtained a device—the adjustable arm hinge—that may be superior to the air splint. The hinge allows complete arm extension while limiting flexion to the degree desired. The amount of flexion permitted can be gradually and easily increased via set screws; when complete flexion is achieved, the device itself can be faded. The elbow hinges may be obtained through Fred Sammons, Inc., Box 32, Brookfield, Illinois 60513.)

Unfortunately, these data provide little information related to the etiology of self-restraint. One explanation for self-restraint is that it is negatively reinforced by escape from or avoidance of SIB (Silverman et al., 1984). Bart's decrease in self-restraint following the administration of the air splints can be interpreted as indirect evidence for the notion that SIB functions as a negative reinforcer for self-restraint. This hypothesis would predict that, once Bart's SIB was eliminated by the air splints, his self-restraint would extinguish because it no longer provided escape or avoidance of SIB (cf. Silverman et al., 1984). On the other hand, Jack's results are more difficult to explain. His self-restraint was eliminated directly, with only a temporary increase in self-injury. Further, the transfer from functional to symbolic restraints observed in Jack and others (e.g., Foxx & Dufrense, 1984) does not appear to be consistent with the negative reinforcement hypothesis because it is unlikely that symbolic restraints could be instrumental in the escape or avoidance of SIB.

Alternatively, self-restraint may occur because it has the same effect on the environment as SIB. For example, self-injury and self-restraint may be maintained in some individuals because both behaviors result in either an escape from environmental demands or an increase in social attention. Furthermore, self-restraint may develop into a predominant behavior, as for Jack and Bart, because it provides reinforcement with less response effort than SIB or because it does not produce the aversive (but tolerable) consequence of SIB. Clearly, more research needs to be undertaken to delineate the variables maintaining self-restraint so that its development can be prevented.

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