

TOWARD A FUNCTIONAL ANALYSIS OF SELF-INJURY

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This study describes the use of an operant methodology to assess functional relationships between self-injury and specific environmental events. The self-injurious behaviors of nine developmentally disabled subjects were observed during periods of brief, repeated exposure to a series of analogue conditions. Each condition differed along one or more of the following dimensions: (1) play materials (present vs absent), (2) experimenter demands (high vs low), and (3) social attention (absent vs noncontingent vs contingent). Results showed a great deal of both between and within-subject variability. However, in six of the nine subjects, higher levels of self-injury were consistently associated with a specific stimulus condition, suggesting that within-subject variability was a function of distinct features of the social and/or physical environment. These data are discussed in light of previously suggested hypotheses for the motivation of self-injury, with particular emphasis on their implications for the selection of suitable treatments.

The description, incidence and damaging effects of self-injury, as well as numerous attempts to control it, have been repeatedly documented in the literature. Self-injury is a bizarre and often chronic form of aberrant behavior, the etiology of which is at best poorly understood. It poses serious risks to those who engage in the behavior, and it represents a formidable challenge to those who are responsible for treating it.

Most of the research on self-injury over the past 15 years has focused on discovering means for its effective elimination. The greatest success has been found using methods based on operant condition-

ing principles (Bachman, 1972; Baumeister & Rollings, 1976; Frankel & Simmons, 1976; Johnson & Baumeister, 1978; Romanczyk & Goren, 1975; Schroeder, Schroeder, Rojahn, & Mulick, 1981; Smolev, 1971). However, some mixed findings have been noted with almost all of the behavioral interventions. For example, although a number of studies have shown that the reinforcement of incompatible or other behavior (DRI/DRO) reduced self-injury (Allen & Harris, 1966; Frankel, Moss, Schofield, & Simmons, 1976; Lovaas, Freitag, Gold, & Kassorla, 1965; Tarpley & Schroeder, 1979), others have reported poor results with DRO/DRI (Corte, Wolf, & Locke, 1971; Measel & Alfieri, 1976; Young & Wincze, 1974). Extinction has been effective in some instances (Jones, Simmons, & Frankel, 1974; Lovaas & Simmons, 1969) but not in others (Corte et al., 1971; Myers, 1975), and conflicting findings also have been reported with both timeout (Adams, Klinge, & Keiser, 1973; Corte et al., 1971; Duker, 1975; Solnick, Rincover, & Peterson, 1977), and over-correction (Azrin, Gottlieb, Hughart, Wesolowski, & Rahn, 1975; Foxx & Martin, 1975; Harris & Romanczyk, 1976; Measel & Alfieri, 1976).

The only treatments that have been consistently effective in treating self-injury are those based on punishment in the form of aversive stimulation

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(Birnbauer, 1968; Corte *et al.*, 1971; Dorsey, Iwata, Ong, & McSween, 1980; Sajwaj, Libet, & Agras, 1974; Tanner & Zeiler, 1975). However, due to concerns regarding the appropriate and safe use of "restrictive" or "intrusive" treatments (e.g., ACFMR, 1971), it has been recommended that punishment be limited to those situations in which other interventions have failed (May, Risley, Twardosz, Friedman, Bijou, Wexler *et al.*, 1975). It is therefore important to conduct research that may eventually identify the limiting conditions of the various treatments for self-injury. It would be especially useful if these conditions were known *prior* to initiating what otherwise might be an arbitrarily determined and seemingly endless series of interventions.

Recent reviews (Carr, 1977; Johnson & Baumeister, 1978) have suggested that some of the treatment failures and inconsistencies reported throughout the literature may reflect a lack of understanding regarding the variables that either produce or maintain self-injury. In discussing a number of hypotheses for the motivation of self-injury, Carr (1977) indicated that the behavior may be reinforced through extrinsic sources (e.g., through positive reinforcement such as attention, or negative reinforcement such as the termination of demands), or that the behavior itself may produce some form of intrinsic reinforcement (e.g., sensory stimulation, pain reduction). This conceptualization of self-injury as a multiply controlled operant would indicate that no single form of treatment can be expected to produce consistent positive results, and it suggests that one means of selecting a potentially effective treatment would consist of first determining what events are currently maintaining the behavior.¹

¹ Punishment would be an exceptional case because its effectiveness does not depend on its ability to alter a reinforcement contingency. Rather, punishment is effective due to the fact that its "aversive" properties are sufficient to overcome *whatever* source of reinforcement is maintaining the behavior (Azrin & Holz, 1966). Given the types of stimuli that typically have been used as punishing events (e.g., electric shock, aromatic ammonia), it is not surprising to find that punishment has been found to be the most effective treatment for self-injury.

For several reasons, very little behavioral research has focused on the environmental determinants of self-injury. First, in light of data from numerous sources suggesting that self-injury is a learned phenomenon, behavioral researchers and clinicians generally have dismissed the importance of etiology, since the conditions that are necessary to develop or maintain a response may be totally unrelated to the conditions that are sufficient to alter or eliminate it. Second, with respect to the initial development of self-injury, functional analyses have been limited to animal studies (Holz & Azrin, 1961; Schaeffer, 1970), since experimental attempts to induce self-injury in humans when it does not already exist would be regarded as unacceptable from the standpoint of subject risk/benefit. Third, the apparent severity of the behavior often suggests the need for immediate attention, thereby discouraging attempts to identify features of the social and physical environment that may serve to maintain self-injury (see Carr, Newsom, & Binkoff, 1976, for a notable exception).

Over the past two years, we have been working toward the development and refinement of an operant methodology whose application might prove useful in identifying the functional properties of self-injury on a pretreatment basis. This article describes and presents the results obtained with our initial assessment protocol, in which subjects' behavior was repeatedly observed across several well-defined analogue environments. Similar approaches have been used to examine the effects of physical aspects of the environment on behaviors such as stereotypy (Adams, Tallon, & Stangl, 1980) and pica (Madden, Russo, & Cataldo, 1980). In the present study, environmental events consisted of both physical and social manipulations that might differentially affect the occurrence of self-injury.

METHOD

Subjects and Setting

Nine subjects participated in the study. All showed some degree of developmental delay, and were admitted for inpatient evaluation and/or treatment to The John F. Kennedy Institute, a

Table 1
Demographic Characteristics of Subjects

Sub- ject	Sex	Age in years	Developmental level	Motor involvement	Diagnosis	Self-injury
1	F	4 $\frac{1}{2}$	2-3 $\frac{1}{2}$ yr	Normal	Mild to moderate mental retardation	Self-biting, head banging
2	M	5 $\frac{10}{12}$	8-12 mo	Spastic cerebral palsy, delayed	Congenital rubella syndrome, profound mental retardation, blind, hearing deficit	Eye gouging, head banging
3	M	13	8-10 mo	Normal (restricted by arm restraints)	Profound mental retardation, Down's syndrome	Ear pulling, head banging
4	M	6 $\frac{8}{12}$	10-15 mo	Normal	Profound mental retardation, autistic-like behavior	Head banging, head hitting
5	M	13 $\frac{1}{2}$	2-3 yr	Poor ambulation, abnormal gait, delayed	Severe to profound mental retardation, Rubenstein-Taybi syndrome	Face slapping, head banging, hand biting
6	M	1 $\frac{1}{2}$	6-9 mo	Delayed	Developmental delay, craniosynostosis	Hand mouthing
7	M	17 $\frac{2}{12}$	15-24 mo	Mild cerebral palsy, delayed	Congenital rubella syndrome, profound mental retardation	Head hitting, head banging, arm biting, self-choking, hair pulling
8	M	4 $\frac{1}{2}$	2-14 mo	Delayed	Profound mental retardation, Down's syndrome	Head hitting, head banging
9	M	3 $\frac{7}{12}$	6-12 mo	Cerebral palsy, left hemiplegia, delayed	Profound mental retardation	Head hitting, head banging

pediatric hospital affiliated with The Johns Hopkins University School of Medicine. Interviews and direct observations conducted prior to admission indicated that each subject exhibited moderate to high rates of self-injurious behavior. Demographic information for each subject is provided in Table 1. Sessions were conducted in 3.0m by 3.0m therapy rooms, equipped with tables and chairs, a variety of games and toys, and either floor carpeting or a mat. Each therapy room was adjoined to a 3.0m by 1.5m observation room via a one-way mirror.

Human Subjects Protection

In order to assess the differential effects of environment on self-injury, the present study required that subjects be allowed to engage in self-injurious behavior while free from mechanical, physical or chemical restraint. All procedures were reviewed and approved by a human subjects committee, and the following safeguards were employed to reduce the risk of physical damage as a function of self-injury exhibited during the observation sessions. First, each subject received a complete medical ex-

amination by a physician, as well as other diagnostic consultations (e.g., neurological, audiological, visual). The purpose of the examination was to assess current physical status and to rule out organic factors that might be associated with or exacerbated by self-injury. Potential subjects who presented an immediate risk of severe physical damage due to self-injury were not included in the study. Second, each subject's physician recommended a criterion (expressed in terms of either degree of injury or level of responding or both) for terminating observation sessions due to physical risk. Physicians and nurses observed sessions intermittently in order to assess subjects' self-injury as it occurred and, if necessary, to modify the criterion. Third, if a subject's physical condition or level of responding met the criterion for terminating a session, (s)he was removed from the therapy room, self-injury was interrupted via brief physical or mechanical restraint, and a physician or nurse examined the subject and either approved continuation or recommended postponement of the sessions. Fourth, following each set of four observation sessions, sub-

Table 2
Observer Definitions of Subjects' Self-injury

Response	Definition	Subjects
Ear pulling & gouging	Closure of fingers, fingernails or hand on ear with a pulling or digging motion	3
Eye gouging	Any contact of any part of hand within the ocular area	2
Face slapping	Forceful contact of the open hand with the face	6
Hair pulling	Closure of the fingers and thumb on hair with a pulling motion away from the head	7
Handmouthing	Insertion of one or more fingers into the mouth	6
Head banging	Forceful contact of the head with a stationary environmental object	1-9
Head hitting	Forceful contact of the hand with any part of the head	4, 5, 7, 9
Neck choking	Forceful closure of both hands around the neck	7
Self-biting	Closure of the upper and lower teeth on the flesh of any portion of the body	1, 5, 7

jects were routinely examined by a nurse who noted any changes in physical status as a result of self-injury. Finally, each subject's case was reviewed at least weekly in both departmental case conferences and interdisciplinary rounds.

In light of the above procedures, it was felt that the degree of risk to which subjects were exposed was no greater (and perhaps considerably less) than that found in their natural environment. During the course of the study, subjects often engaged in self-injury to the extent that minor bleeding or swelling occurred; however, at no time did subjects require any medical care due to their self-injury other than routine cleaning and/or topical dressing by a nurse. On three occasions, a session was terminated prematurely for subject 7, due to an extremely high rate of forceful head banging against the floor of the observation room. However, self-injury was never severe enough to require the termination of a session for other subjects, and no subject was ever excluded from participation in sessions due to residual effects of accumulated self-injury.

Response Definitions and Measurement

Observations conducted prior to and upon admission indicated that all subjects engaged in two or more self-injurious topographies, with head banging the most prevalent. Table 2 contains a

listing of the specific self-injurious responses observed for each subject, along with operational definitions used in collecting data.

During each session, an observer recorded the occurrence or nonoccurrence of self-injurious behavior from the observation room during continuous, 10-sec intervals (Powell, Martindale, & Kulp, 1975). Interval changeovers were signalled by a cassette tape containing pre-recorded prompts. The dependent variable of interest consisted of the percentage of intervals during which one or more self-injurious responses were scored, and was calculated by dividing the number of positively scored intervals by the total number of intervals, and multiplying by 100.

Interobserver Agreement

Two observers independently scored responses during 35% of the sessions (the range for individuals was 17% to 67%). Overall, occurrence, and nonoccurrence reliability percentages 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 (Bailey & Bostow, 1979; Hawkins & Dotson, 1975). Overall, occurrence, and nonoccurrence agreement averaged 96.8%, 82.8%, and 91.7%, respectively. Individual means and ranges for each subject are presented in Table 3. Lower agreement

Table 3
Interobserver Agreement Data

Subject	Percent of observations for which observer agreement was measured	Overall		Occurrence		Nonoccurrence	
		$\bar{X}\%$	Range	$\bar{X}\%$	Range	$\bar{X}\%$	Range
1	26.6	99.8	98-100	84.3	50-100	99.7	97-100
2	67.0	88.0	63-100	80.4	41-100	63.2	27-100
3	32.0	98.8	88-100	95.0	75-100	97.8	83-100
4	17.0	96.3	94-99	86.8	78-95	80.0	39-99
5	25.0	99.7	97-100	93.5	75-100	99.3	98-100
6	17.0	100	100	100	100	100	100
7	61.3	92.4	73-100	72.9	21-100	88.8	61-100
8	45.0	97.0	91-100	85.5	43-100	97.5	90-100
9	30.3	99.2	96-100	46.9	0-100	99.0	95-100

percentages were obtained during sessions in which subjects exhibited either extremely high or extremely low levels of responding.

Staff Training

All observers and experimenters who participated in the study had previous coursework and experience in the use of behavioral interventions with developmentally disabled children. In addition, specific training activities were employed to ensure that staff could reliably observe behavior and respond appropriately during sessions in which they served as an experimenter. Each staff member received written instructions describing the observation procedure and experimental protocol. After reading and reviewing these materials with an experienced staff member, a new staff member was assigned to conduct informal observations, reliability observations, and primary data observations for approximately five sessions each. Persons serving as experimenters (i.e., those conducting sessions) did so only after demonstrating competence as an observer. At least one of the authors was present during each session and provided feedback regarding compliance with the procedures as needed.

Experimental Conditions

Eight of the nine subjects were exposed to each of four different conditions in an experimental de-

sign that used a multielement manipulation (Barlow & Hayes, 1979; Sidman, 1960; Ulman & Sulzer-Azaroff, 1975). Subject 1, who served as a pilot, was exposed to three of the four conditions. Eight sessions (two per condition) were conducted each day, with four sessions occurring in the morning and four in the afternoon. The order of presentation for each series of four sessions was determined by random drawing. Each session lasted for 15 min, with the exception of the three occasions noted earlier. For those conditions requiring the presence of an experimenter in the room with a subject, at least three different persons were trained to conduct sessions for each subject, and were rotated to control for experimenter-specific effects. Within each series of conditions, experimenters were changed between sessions, and subjects were briefly removed from the room.

Social disapproval. The experimenter and subject entered the therapy room together, where a variety of toys were available on a table and the floor, within easy reach of the subject. The experimenter directed the subject to "play with the toys" while the experimenter "does some work." If the subject had questionable receptive language or poor hearing, the experimenter initially placed the subject in physical contact with the toys. The experimenter then sat in a chair across the room and assumed the appearance of reading a book or mag-

azine. Attention was given to the subject contingent upon each episode of self-injury (either a single response or a rapid burst of responses), and took the form of statements of concern and disapproval (e.g., "Don't do that, you're going to hurt yourself"; "Look at your hand, don't hit yourself"; etc.), paired with brief physical contact of a non-punitive nature (e.g., hand on shoulder). All other responses exhibited by the subject were ignored. This condition was designed to approximate one type of reinforcement contingency that might maintain self-injury. In the natural environment, especially in institutional settings having low staff-to-client ratios, self-injury often produces much emotional behavior and attention from caregivers, while other behavior receives relatively little attention (Frankel & Simmons, 1976; Lovaas *et al.*, 1965; Lovaas & Simmons, 1969; Risley, 1968). Thus, statements of concern and social disapproval paired with physical contact contingent upon self-injury may maintain the behavior via inadvertent delivery of positive reinforcement.

Academic demand. Educational activities appropriate for each subject were selected on the basis of a special education evaluation conducted upon admission, or from an individual education program plan obtained from the subject's current school or institutional placement. Examples of the educational tasks included: placing plastic rings on a peg, stacking wooden blocks or placing them in a bucket, putting pieces in a wooden puzzle, threading large plastic beads on a string, grasping and holding small objects, and touching various body parts upon request. The tasks were judged to have a low probability of occurrence, in that subjects never completed them spontaneously. In addition, the tasks were apparently difficult for subjects to perform even when physically guided.

During the academic session, the experimenter and subject were seated at a table, and the experimenter presented learning trials using a graduated, three-prompt procedure (Horner & Keilitz, 1975; Tucker & Berry, 1980). The experimenter initially gave a verbal instruction and allowed the subject 5 sec to initiate a response. If, after the 5 sec, the subject failed to initiate an appropriate response,

the experimenter repeated the instruction, modeled the correct response, and waited an additional 5 sec. If no response occurred at that point, the experimenter repeated the instruction and physically guided the subject through the response, using the least amount of contact necessary to complete it. Appropriate modification and/or elimination in the first two steps occurred for subjects with auditory or visual deficits. Social praise was delivered upon completion of the response, regardless of whether or not modeling or physical guidance were required, and the next trial was begun. Contingent upon the occurrence of self-injury at any time during the session, the experimenter immediately terminated the trial and turned away from the subject for 30 sec, with an additional 30-sec change-over delay for repeated self-injury. While such a consequence for self-injury might resemble an extinction procedure, it was actually designed to assess whether or not self-injury was maintained through negative reinforcement as a result of escaping or avoiding demand situations (Carr, 1977; Carr *et al.*, 1976; Jones, Simmons, & Frankel, 1974; Measel & Alfieri, 1976; Wolf, Risley, Johnston, Harris, & Allen, 1967).

Unstructured play. As in the two previous conditions, an experimenter and subject were present in the room. No educational tasks were presented, and a variety of toys were available within the subject's reach. Throughout the session, the experimenter maintained close proximity to the subject (i.e., within 1m when both were seated), allowed the subject to engage in spontaneous isolate or cooperative toy play or to move freely about the room, and periodically presented toys to the subject without making any demands. The experimenter delivered social praise and brief physical contact contingent upon appropriate behavior—the absence of self-injury—at least once every 30 sec. Self-injurious behavior was ignored, unless its severity reached the point where the session was terminated. This condition served as a control procedure for the presence of an experimenter, the availability of potentially stimulating materials, the absence of demands, the delivery of social approval for appropriate behavior, and the lack of approval for

self-injury. Additionally, it was designed to serve the function of an "enriched environment" (Horner, 1980), in which relatively little self-injury might be expected to occur.

Alone. The child was placed in the therapy room alone, without access to toys or any other materials that might serve as external sources of stimulation. The purpose of this condition was to approximate a situation that would be considered "impoverished" or "austere" from a social and physical standpoint (Horner, 1980). There is growing evidence to suggest that self-stimulatory behavior is motivated through self-produced reinforcement of a sensory nature (Rincover, 1978; Rincover, Cook, Peoples, & Packard, 1979), and it is possible that self-injury may be similarly maintained (Carr, 1977; Dorsey, Iwata, Reid, & Davis, in press; Favell, McGimsey, & Schell, 1982; Parrish, Aguerrevere, Dorsey, & Iwata, 1980; Rincover & Devany, 1982). If so, one might expect to observe higher levels of self-injury in situations where minimal amounts of stimulation are provided by the environment.

The above procedures continued until: (1) apparent stability in the level of self-injury was observed, (2) unstable levels of responding persisted in all conditions for 5 days, or (3) 12 days of sessions were completed. The length of subject participation in this study averaged 8 days (range = 4–11), while the total number of sessions run per subject averaged 30 (range = 24–53).

RESULTS

Figure 1 summarizes the results for the nine subjects. For each subject, the numerical data in Figure 1 indicate the overall mean percent of intervals of self-injury and its standard deviation, and means for the separate experimental conditions. These data allow for an examination of overall responding between subjects, as well as condition-by-condition comparisons within subjects. However, in light of the rather large differences observed in subjects' overall level of self-injury, it is difficult to make condition-by-condition comparisons between subjects on the basis of absolute data alone (e.g., 81.3% vs 44.4% vs 8.9% self-injury for sub-

jects 4, 7, and 9, respectively, during the Alone condition). For this reason, the condition means for individual subjects are also portrayed graphically in standard deviation units above or below a subject's overall mean. Thus, Figure 1 provides a summary of both absolute level and relative variability of subjects' self-injurious behavior.

Several differences can be seen in the present data. First, the level of responding varied widely across subjects, with the overall mean percent of intervals of self-injury ranging from a low of 4.5% (subjects 1 and 9) to a high of 91.2% (subject 6). Second, considerable variability was observed within subjects across the different experimental conditions. The within-subject variability was evident regardless of a subject's overall level of responding. For example, subjects 1 and 6, who displayed markedly different overall levels of self-injury, both showed variable responding across conditions. Third, within-subject patterns of responding did not appear related to the overall level of self-injury. For example, subjects 3 and 9, both of whom displayed relatively little self-injury, differed with respect to the condition in which self-injury was found to be the greatest.

In spite of the above differences, the data provide information regarding specific conditions that may affect self-injury, and the results shown in Figure 1 suggest five general patterns of responding for the present subjects. The first pattern was characterized by a relatively low level of self-injury during the Unstructured play condition. For all of the eight subjects exposed to this condition (subject 1 was excluded), self-injury during Unstructured play was at or below their overall mean level, and four of the subjects (subjects 2, 4, 5, 9) showed less self-injury during Unstructured play when compared to any of the other conditions. A second pattern was reflected in the data for subjects 4, 6, 7, and 9. For these individuals, self-injury was greatest during the Alone condition, in which access to external sources of stimulation was minimized. This pattern is most clearly evident in subject 4's data. However, subjects 6 and 9, whose overall level of self-injury differed considerably, also displayed more self-injury during the Alone condition. A third pat-

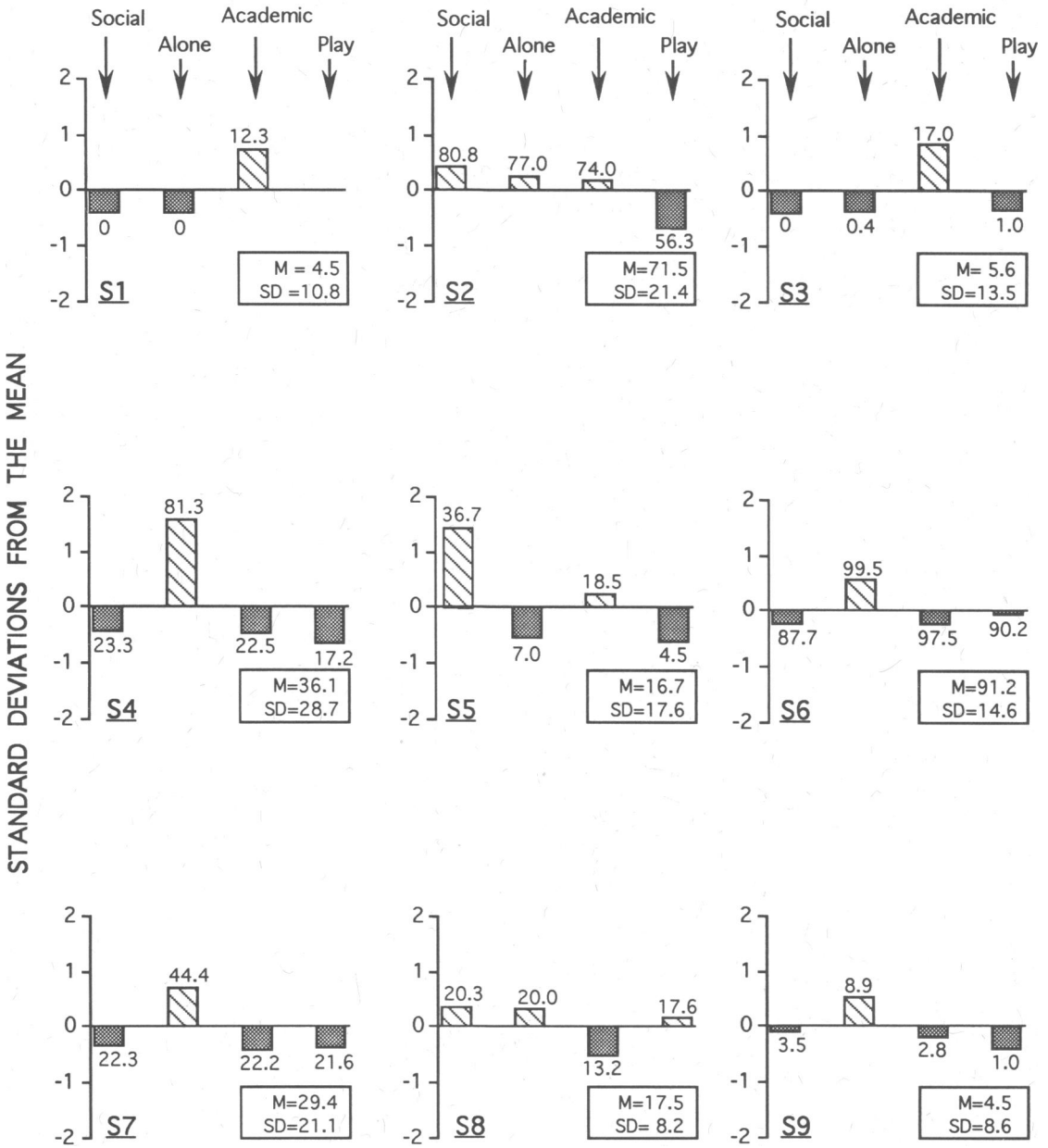


Figure 1. Summary data for subjects 1–9 across experimental conditions. The numbers to the right of each graph show a subject’s overall mean percent of intervals of self-injury and its standard deviation, while the numbers above/below each bar represent the mean percent of intervals of self-injury per condition. The solid/open bars portray each condition mean in standard deviation units above/below the subject’s overall mean.

tern of results was suggested by the data for subjects 1 and 3. Both of these individuals exhibited little or no self-injury during all but one of the conditions—the High demand situation. Subject 5 exemplified a fourth pattern in which self-injury oc-

curred most often during the Social disapproval condition. Finally, the data for subjects 2 and 8 showed an undifferentiated pattern, in that they exhibited either very high (subject 2) or similar (subject 8) amounts of self-injury across two or

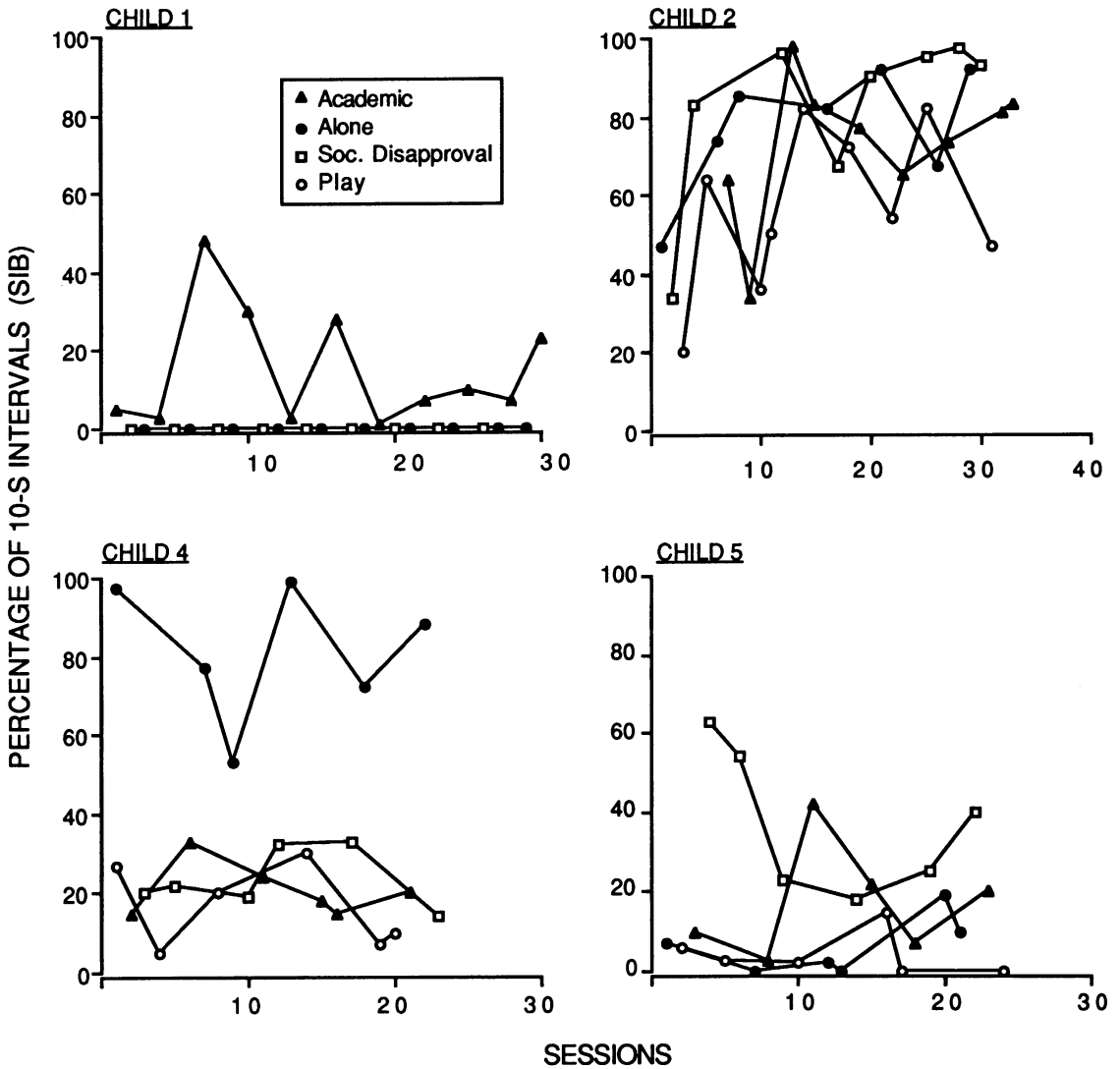


Figure 2. Percentage of intervals of self-injury for subjects 1, 2, 4, and 5 across sessions and experimental conditions.

more conditions. Subject 6's data might also be considered an example of undifferentiated responding merely because he exhibited very high levels of self-injury across all conditions, even though the greatest amount was seen during the Alone condition.

Figure 2 presents session-by-session data for four subjects whose results are characteristic of different response patterns. Subjects 1, 4, and 5 exhibited higher levels of self-injury during the Academic demand, Alone, and Social disapproval conditions, respectively, while subject 2 engaged in relatively

high levels of self-injury across all experimental conditions.

DISCUSSION

Present results indicate that the occurrence of self-injury varies considerably, both between and within individuals. More importantly, the data show that within-subject variability is not merely a random process. In six of the nine subjects, higher levels of self-injury were consistently associated with a specific stimulus condition. These results provide

direct empirical evidence that self-injury may be a function of different sources of reinforcement (Carr, 1977), a finding that has significant implications for treatment.

In four of our subjects, self-injury was relatively high during the Alone condition, suggesting a form of self-stimulation as a motivational variable. Assuming that this analysis is a correct one, knowledge of the specific reinforcing event provided by self-injury would greatly enhance the effectiveness of reinforcement procedures designed to reduce the behavior. For example, on several occasions, we have noticed that visually impaired clients engage in eye-poking that probably intensifies visual stimulation. Intervention for such individuals might include the use of bright flashing lights, massage to the ocular area, etc., that is delivered contingent upon the absence of self-injury, or produced by a response that is incompatible with self-injury (Favell *et al.*, 1982). Alternatively, effective extinction procedures may not require the withholding of social consequences but, instead, the elimination or attenuation of sensory stimulation derived from the response (e.g., Dorsey *et al.*, *in press*; Rincover, 1978; Rincover *et al.*, 1979; Rincover & Devany, 1982).

Two subjects exhibited more self-injury during the Academic sessions, where the behavior functioned to briefly terminate demands made by an experimenter. The pattern of behavior shown by these subjects resembles that described by Carr *et al.* (1976) who were able to reduce self-injury by including non-demand periods (reading entertaining stories to the subject) during a demand condition. The use of "guided compliance" trials, in which a client's self-injury is followed by physical assistance in completing the desired academic response and continuation of the session until a performance criterion is reached, might also be effective in "extinguishing" the negative reinforcement provided through escape responding. On the other hand, a typical extinction technique—the contingent withdrawal of attention—would be expected to strengthen the behavior.

Only one subject in the present study showed higher levels of self-injury during the Social dis-

approval condition. This finding was rather surprising in light of the fact that social attention often has been suggested as a likely source of reinforcement for self-injury. However, in situations where it can be determined that clients engage in self-injury for the attention that it produces, extinction (ignoring), timeout, and DRO would seem to be the most effective treatments.

Three of the subjects showed either undifferentiated patterns or high levels of self-injury across all stimulus conditions. Although it is impossible to determine what may have accounted for these results, several possibilities appear likely. Each of these subjects was either quite young or profoundly retarded, and it is possible that the different conditions were not clearly discriminable to them. Alternatively, the behavior may have been a function of variables that were not controlled in the present study. Finally, self-injury in these individuals may represent a response that serves multiple functions—providing stimulation when little is available, producing attention from others, and terminating undesirable situations. The latter possibility is most significant in that it suggests the need for different treatments applied to the same individual, depending upon the situation in which self-injury is observed.

Although clear differences were observed in a majority of our subjects, the present data must be regarded as limited in two respects. First, our methodology did not control for very subtle aspects of contingencies that may affect behavior. For example, assuming that the attention provided during the Social disapproval condition serves a reinforcing function, the reinforcement is provided on a very frequent basis.² The Alone condition differed from the Social attention condition in at least two respects: it not only represented a condition of stim-

² The use of these schedules raises the question of whether or not procedures in this study could have contributed to the development of self-injury in our subjects. Data indicating an increasing function across time would have suggested that learning or acquisition was taking place. However, only the data for subject 2 showed any increase across sessions, and it can be seen (Figure 2) that this subject's self-injury was occurring at high levels during initial sessions.

ulus deprivation, but also eliminated access to all social attention. In light of the fact that an operant response may occur at higher rates during the initial stages of extinction than during a CRF condition, a high level of self-injury during the Alone condition *might not* be maintained by reinforcement of a self-stimulatory nature, but by the withdrawal of social reinforcement. Thus, our methodology does not isolate conclusively the exact nature of the contingency responsible for maintaining self-injury, and we foresee the need for constructing an extended series of conditions that progressively analyzes variables such as reinforcement schedules. A second limitation can be found in the incompleteness of our analysis. For example, if subjects exhibit self-injury primarily in demand situations, a reduction of self-injury following a reversal of the apparent contingency operating in that environment (i.e., the elimination of escape as a consequence for self-injury) would provide stronger evidence that the behavior was, in fact, maintained through negative reinforcement. Furthermore, a comparison of that technique to one whose use is unrelated to the concept of negative reinforcement for self-injury (e.g., timeout, DRO) would provide the ultimate test of the clinical utility of the assessment procedure in selecting effective treatments. Although no treatment data are included in this study, all of the present subjects were provided a therapy program following the completion of their assessment. During the course of that treatment, we have conducted several types of intervention analyses, the results of which have been very encouraging in cases where self-injury was clearly differentiated during the assessment period.

In addition to the above limitations, several distinctive features of the present study are worth noting. The use of environments that may not closely resemble naturalistic situations was based on our experience that it is often difficult to either precisely identify or control naturally occurring events related to self-injury. Also, by using well-defined analogue environments, it was possible to limit subjects' inclusion in the study to an amount of time no greater than that of a typical baseline period, yet provide data on a number of variables that may affect self-

injury. Both of these features (operational definition of the environment and limited duration) should increase the likelihood that the present methodology, or one similar to it, could be incorporated into the design of most intervention research. Procedures for minimizing risks to subjects were also carefully considered, and provide a model for screening and monitoring that might be considered essential in research of this type. In particular, the independent monitoring system was seen as a safeguard to experimenters as well as subjects, and should be employed whenever possible.

The major focus of the present study was on the identification of variables that are associated with (and may serve to maintain) the occurrence of self-injury. However, it is important to note that lower levels of self-injury were consistently associated with the control condition, which included the availability of toys, the relative absence of demands, and reinforcement for behavior that was generally incompatible with self-injury. This finding is consistent with previous data (Horner, 1980) suggesting that physical and social characteristics associated with an "enriched environment" may produce a number of beneficial outcomes, including reductions in self-injury. In addition to enrichment, in cases where individuals exhibit few adaptive behaviors, successful treatment of self-injury may include the active shaping and/or reinforcement of specific appropriate responses, such as toy play (Favell et al., 1982).

In summary, the present study offers a methodology for examining the multiple effects of environment on the occurrence of self-injury. Whether or not it will contribute to a more thorough understanding of the etiology of self-injury remains to be seen.³ However, it is clear that improvements are needed in our approach to the treatment of self-injury. The present results suggest that it may be

³ The present study does not address the issue of environmental versus physiological determinants of self-injury. However, assuming that there may be a physiological basis for the development or maintenance of self-injury, research of the present type should suggest ways to reduce the effects of environmental variance when conducting biobehavioral investigations.

possible to empirically identify variables that affect self-injury prior to implementing lengthy treatment conditions. If so, we can no longer afford to conduct clinical research in which the baseline data provide information regarding behavior in a single invariant situation, or to make treatment decisions based on a "best guess" as to what might constitute the most effective means of intervention.

REFERENCES

- Accreditation Council for Facilities for the Mentally Retarded. (1971). *Standards for residential facilities for the mentally retarded*. Chicago: Joint Commission on Accreditation of Hospitals.
- Adams, G. L., Tallon, R. J., & Stangl, J. M. (1980). Environmental influences on self-stimulatory behavior. *American Journal of Mental Deficiency, 85*, 171-175.
- Adams, K. M., Klinge, V., & Keiser, T. W. (1973). The extinction of a self-injurious behavior in an epileptic child. *Behavior Research and Therapy, 11*, 351-356.
- Allen, K. E., & Harris, F. R. (1966). Elimination of a child's excessive scratching by training the mother in reinforcement procedures. *Behavior Research and Therapy, 4*, 79-84.
- Azrin, N. H., Gottlieb, L., Hughart, L., Wesolowski, M. D., & Rahn, T. (1975). Eliminating self-injurious behavior by educative procedures. *Behavior Research and Therapy, 13*, 101-111.
- Azrin, N. H., & Holz, W. C. (1966). Punishment. In W. K. Honig (Ed.), *Operant behavior: Areas of research and application*. New York: Appleton-Century-Crofts.
- Bachman, J. A. (1972). Self-injurious behavior: A behavioral analysis. *Journal of Abnormal Psychology, 80*, 211-224.
- Bailey, J. S., & Bostow, D. E. (1979). *Research methods in applied behavior analysis*. Tallahassee, FL: Copy Graph.
- Barlow, D. H., & Hayes, S. C. (1979). Alternating treatments design: One strategy for comparing the effects of two treatments in a single subject. *Journal of Applied Behavior Analysis, 12*, 199-210.
- Baumeister, A. A., & Rollings, J. P. (1976). Self-injurious behavior. In N. R. Ellis (Ed.), *International review of research in mental retardation*. New York: Academic Press.
- Birnbrauer, J. (1968). Generalization of punishment effects—A case study. *Journal of Applied Behavior Analysis, 1*, 201-211.
- Carr, E. G. (1977). The motivation of self-injurious behavior: A review of some hypotheses. *Psychological Bulletin, 84*, 800-816.
- Carr, E. G., Newsom, C. D., & Binkoff, J. A. (1976). Stimulus control of self-destructive behavior in a psychotic child. *Journal of Abnormal Child Psychology, 4*, 139-152.
- Corre, H. E., Wolf, M. M., & Locke, B. J. (1971). A comparison of procedures for eliminating self-injurious behavior of retarded adolescents. *Journal of Applied Behavior Analysis, 4*, 201-213.
- Dorsey, M. F., Iwata, B. A., Ong, P., & McSween, T. E. (1980). Treatment of self-injurious behavior using a water mist: Initial response suppression and generalization. *Journal of Applied Behavior Analysis, 13*, 343-353.
- Dorsey, M. F., Iwata, B. A., Reid, D. H., & Davis, P. A. (in press). Protective equipment: Continuous and contingent application in the treatment of self-injurious behavior. *Journal of Applied Behavior Analysis*.
- Duker, P. (1975). Intra-subject controlled time-out (social isolation) in the modification of self-injurious behavior. *Journal of Mental Deficiency Research, 19*, 107-112.
- Favell, J. E., McGimsey, J. F., & Schell, R. M. (1982). Treatment of self-injury by providing alternative sensory activities. *Analysis and Intervention in Developmental Disabilities, 2*, 83-104.
- Foxx, R. M., & Martin, E. D. (1975). Treatment of scavenging behavior (coprophagy and pica) by over-correction. *Behavior Research and Therapy, 13*, 153-162.
- Frankel, F., Moss, D., Schofield, S., & Simmons, J. Q. (1976). Case study: Use of differential reinforcement to suppress self-injurious and aggressive behavior. *Psychological Reports, 39*, 843-849.
- Frankel, F., & Simmons, J. Q. (1976). Self-injurious behavior in schizophrenic and retarded children. *American Journal of Mental Deficiency, 80*, 512-522.
- Harris, S. L., & Romanczyk, R. G. (1976). Treating self-injurious behavior of a retarded child by over-correction. *Behavior Therapy, 7*, 235-239.
- Hawkins, R. P., & Dotson, V. A. (1975). Reliability scores that delude: An "Alice in Wonderland" trip through the misleading characteristics of interobserver agreement scores in interval recording. In E. Ramp & G. Semb (Eds.), *Behavior analysis: Areas of research and application*. Englewood Cliffs, New Jersey: Prentice-Hall.
- Holz, W. C., & Azrin, N. H. (1961). Discriminative properties of punishment. *Journal of the Experimental Analysis of Behavior, 4*, 225-232.
- Horner, R. D. (1980). The effects of an environmental "enrichment" program on the behavior of institutionalized profoundly retarded children. *Journal of Applied Behavior Analysis, 13*, 473-491.
- Horner, R. D., & Keilitz, I. (1975). Training mentally retarded adolescents to brush their teeth. *Journal of Applied Behavior Analysis, 8*, 301-309.
- Johnson, W. L., & Baumeister, A. (1978). Self-injurious behavior: A review and analysis of methodological details of published studies. *Behavior Modification, 2*, 465-484.
- Jones, F. H., Simmons, J. Q., & Frankel, F. (1974). An extinction procedure for eliminating self-destructive behavior in a 9-year-old autistic girl. *Journal of Autism and Childhood Schizophrenia, 4*, 214-250.
- Lovaas, O. I., Freitag, G., Gold, V. J., & Kassorla, I. C. (1965). Experimental studies in childhood schizophre-

- nia: Analysis of self-destructive behavior. *Journal of Experimental Child Psychology*, 2, 67-84.
- Lovaas, O. I., & Simmons, J. Q. (1969). Manipulation of self-destruction in three retarded children. *Journal of Applied Behavior Analysis*, 2, 143-157.
- Madden, N. A., Russo, D. C., & Cataldo, M. F. (1980). Environmental influences on mouthing in children with lead intoxicification. *Journal of Pediatric Psychology*, 5, 207-216.
- May, J. G., Risley, T. R., Twardosz, S., Friedman, P., Bijou, S., Wexler, D., et al. (1975). Guidelines for the use of behavioral procedures in state programs for the retarded. NARC Monograph, *M. R. Research*, 1.
- Measel, C. J., & Alfieri, P. A. (1976). Treatment of self-injurious behavior by a combination of reinforcement for incompatible behavior and overcorrection. *American Journal of Mental Deficiency*, 81, 147-153.
- Myers, D. V. (1975). Extinction, DRO, and response cost procedures for eliminating self-injurious behavior: A case study. *Behavior Research and Therapy*, 13, 189-191.
- Parrish, J. M., Aguerrevere, L., Dorsey, M. F., & Iwata, B. A. (1980). The effects of protective equipment on self-injurious behavior. *The Behavior Therapist*, 3, 28-29.
- Powell, J., Martindale, A., & Kulp, S. (1975). An evaluation of time-sampling measures of behavior. *Journal of Applied Behavior Analysis*, 8, 463-469.
- Rincover, A. (1978). Sensory extinction: A procedure for eliminating self-stimulatory behavior in psychotic children. *Journal of Abnormal Child Psychology*, 6, 299-310.
- Rincover, A., Cook, R., Peoples, A., & Packard, D. (1979). Sensory extinction and sensory reinforcement principles for programming multiple adaptive behavior change. *Journal of Applied Behavior Analysis*, 12, 221-233.
- Rincover, A., & Devany, J. (1982). Using sensory reinforcement and sensory extinction principles in the treatment of self-injury. *Analysis and Intervention in Developmental Disabilities*, 2, 67-81.
- Risley, T. R. (1968). The effects and side effects of punishing the autistic behaviors of a deviant child. *Journal of Applied Behavior Analysis*, 1, 21-34.
- Romanczyk, R. G., & Goren, E. R. (1975). Severe self-injurious behavior: The problem of clinical control. *Journal of Consulting and Clinical Psychology*, 43, 730-739.
- Sajwaj, T., Libet, J., & Agras, S. (1974). Lemon-juice therapy: The control of life-threatening rumination in a six-month-old infant. *Journal of Applied Behavior Analysis*, 7, 557-563.
- Schaeffer, H. H. (1970). Self-injurious behavior: Shaping "head banging" in monkeys. *Journal of Applied Behavior Analysis*, 3, 111-116.
- Schroeder, S. R., Schroeder, C. S., Rojahn, J., & Mulick, J. A. (1981). Self-injurious behavior: An analysis of behavior management techniques. In J. L. Matson & J. R. McCartney (Eds.), *Handbook of behavior modification with the mentally retarded*. New York: Plenum Press.
- Sidman, M. (1960). *Tactics of scientific research*. New York: Basic Books.
- Smolev, S. R. (1971). Use of operant techniques for the modification of self-injurious behavior. *American Journal of Mental Deficiency*, 76, 295-305.
- Solnick, J. V., Rincover, A., & Peterson, C. R. (1977). Some determinants of the reinforcing and punishing effects of timeout. *Journal of Applied Behavior Analysis*, 10, 415-424.
- Tanner, B. A., & Zeiler, M. (1975). Punishment of Self-injurious behavior using aromatic ammonia as the aversive stimulus. *Journal of Applied Behavior Analysis*, 8, 53-57.
- Tarpley, H. D., & Schroeder, S. R. (1979). Comparison of DRO and DRI on rate of self-injurious behavior. *American Journal of Mental Deficiency*, 84, 188-194.
- Tucker, D. J., & Berry, G. W. (1980). Teaching severely multihandicapped students to put on their own hearing aids. *Journal of Applied Behavior Analysis*, 13, 65-75.
- Ulman, J. D., & Sulzer-Azaroff, B. (1975). Multielement baseline design in educational research. In E. Ramp & G. Semb (Eds.), *Behavior analysis: Areas of research and application*. Englewood Cliffs, New Jersey: Prentice-Hall.
- Wolf, M. M., Risley, T., Johnston, M., Harris, F., & Allen, E. (1967). Application of operant conditioning procedures to the behavior problems of an autistic child: A follow-up and extension. *Behavior Research and Therapy*, 5, 103-111.
- Young, J. A., & Wincze, J. P. (1974). The effects of the reinforcement of compatible and incompatible alternative behaviors on the self-injurious and related behaviors of a profoundly retarded female adult. *Behavior Therapy*, 5, 614-623.