JOURNAL OF APPLIED BEHAVIOR ANALYSIS 2003, **36,** 205–219 NUMBER 2 (SUMMER 2003)

FUNCTIONAL ANALYSIS AND TREATMENT OF SELF-INJURIOUS BEHAVIOR IN YOUNG CHILDREN: A SUMMARY OF 30 CASES

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The assessment and treatment of self-injurious behavior (SIB) has received much attention in the literature; however, few studies have focused on early intervention for this behavior. In the current study, functional analyses with developmentally appropriate modifications were conducted in an outpatient clinic with 30 children (aged 10 months to 4 years 11 months) to assess SIB and problem behavior in its early stages. The reported mean age of SIB onset was 17 months, and head banging was the most prevalent topography. Functional analyses identified sources of reinforcement for SIB in 62.1% of cases; with the inclusion of all forms of problem behavior, sources of reinforcement were identified for 87.5% of cases. Function-based treatments were developed for 24 cases, with functional communication training prescribed most often (70.8% of cases). Implications of these findings for the development of early intervention programs for SIB are discussed.

DESCRIPTORS: caregivers, development, functional analysis, self-injurious behavior

Self-injurious behavior (SIB) is a serious, chronic problem affecting approximately 10% to 14% of individuals with mental retardation (Iwata & Rodgers, 1992). As individuals with SIB reach adolescence and adulthood, the negative impact of SIB becomes increasingly apparent, with consequences including ongoing injuries and health problems, increased social isolation, restricted educational and vocational opportunities, and costly medical and residential care. Ultimately, the presence of chronic, severe SIB predicts poor long-term outcome (National Institutes of Health, 1989).

Given the scope of this problem, it is surprising that little research has focused on the early identification and treatment of SIB. SIB occurs in typically developing and developmentally delayed infants, toddlers, and preschoolers. Head banging is the most common topography of SIB displayed by young children but is generally a transient problem (de Lissovoy, 1962; Sallustro & Atwell, 1978). Romanczyk, Kistner, and Plienis (1982) reported the prevalence of SIB to be 15% in infants aged 9 to 18 months and 9% in 2-year-olds, with fewer cases reported by age 5 years. With respect to children with severe disabilities, both retrospective (Schneider, Bijam-Schulte, Janssen, & Stolk, 1996) and observational (Berkson, Tupa, & Sherman, 2001) studies report the emergence of SIB prior to the age of 5 years.

Murphy, Hall, Oliver, and Kissi-Debra (1999) and Hall, Oliver, and Murphy (2001) documented the emergence and progression of SIB in children with developmental disabilities. Murphy et al. studied 17 children (mean age, 5 years 6 months) that

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Data from Case 23 have been accepted for publication in the *Journal of Developmental and Physical Disabilities.*

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teachers identified as displaying early signs of SIB. Data collected at 3-month intervals over an 18-month period indicated that the SIB of two thirds of the children gradually increased across time. Regression analyses conducted to identify predictor variables for SIB yielded only one moderate correlation ($r = 0.53$, $p < .05$) between degree of teacher concern about potential SIB and increase in SIB. Descriptive analyses from videotaped observations of these same participants (Hall et al.) did not identify any relation between increases SIB and the occurrence of environmental events of demand, attention, demand removal, or attention removal. However, early SIB was significantly associated with low levels of social interaction.

A great deal of research has focused on identifying social functions of severe problem behavior using functional analysis methodology (Iwata, Dorsey, Slifer, Bauman, & Richman, 1982/1994) and function-based interventions (Pelios, Morren, Tesch, & Axelrod, 1999). Iwata, Pace, et al. (1994) demonstrated the utility of functional analysis methodology in an epidemiological study of behavioral function for 152 individuals with SIB. Functions for SIB were identified for 95% of the cases. In addition, function-based treatments effectively reduced SIB by 90% or greater. However, comparatively few studies have examined the functions of SIB and other forms of problem behavior during its early stages, or its treatment at that point.

Two exceptions are studies by Wacker et al. (1998) and Reeve and Carr (2000). Wacker et al. conducted functional analyses in home settings with 28 children (aged 1 to 6 years) with developmental disabilities who displayed varied behavior problems. Results from these parent-conducted assessments indicated that problem behavior served social functions for the majority of children: 21% exhibited problem behavior maintained by positive reinforcement, 46% exhibited problem behavior maintained by negative reinforcement, and 18% engaged in problem behavior that was multiply controlled. Parents were trained to implement reinforcement-based interventions, and follow-up observations conducted up to 12 months posttreatment showed that, as problem behavior decreased during treatment, collateral improvements in social behavior were observed. Reeve and Carr compared two language-based interventions for 8 children with developmental disabilities (aged 2 to 5 years) who exhibited minor problem behaviors maintained by attention. Four of the children were taught an attention-seeking response (e.g., "Look at what I'm doing!") via functional communication training (FCT group), and 4 children received expressive language skills training (ELT group) that was similar to their early intervention curriculum. Results indicated that behavior problems decreased and communication responses increased for the children in the FCT group. In contrast, behavior problems increased for children in the ELT group but then decreased following subsequent implementation of FCT treatment.

Although Wacker et al. (1998) and Reeve and Carr (2000) did not focus solely on SIB, their findings suggest that functional analysis procedures may be applicable to very young children who exhibit an early onset of SIB, and may be useful in developing treatments that could ultimately improve their prognosis. Indeed, the benefits of early intervention are well documented for children with economic disadvantages (Ramey & Campbell, 1992) and for children with autism (Jacobson, Mulick, & Green, 1998; Lovaas, 1987; McEachin, Smith, & Lovaas, 1993).

The current study is an examination of the onset of SIB in 30 young children, the functions of this behavior, and the effectiveness of early behavioral treatment. The aims of the study were (a) to document early histories of children under age 5 years who exhibited severe SIB, (b) to adapt functional

analysis methodology for this population to assess the functions of SIB and other problem behavior in their early stages, and (c) to develop function-based interventions for these children.

METHOD

Participants and Setting

The participants were 30 children under the age of 5 years (M = 2 years 9 months), who had been referred within a 3-year period for assessment and treatment of severe SIB. Participants included 17 boys and 13 girls. At the time of referral, all participants exhibited SIB on a daily basis with resultant tissue damage. Head banging was the most prevalent topography of SIB, present in 83% of the children. On average, participants engaged in at least three topographies of SIB (range, 1 to 5). Although SIB was identified as the primary target behavior at the time of referral, all but 4 of the children engaged in other problem behavior as well: 87% displayed aggression, 60% displayed disruptive behavior, 37% displayed dangerous behavior such as touching electrical sockets, and 77% of participants exhibited tantrums. The reported age of SIB onset, chronological age, medical diagnosis, and level of functioning for each participant are presented in Table 1.

All participants received intensive services in a hospital-based outpatient program for individuals with developmental disabilities and severe problem behavior. Assessment and treatment sessions were conducted with each participant for 2 to 3 hr per day, usually 2 to 3 days per week for 12 to 16 weeks. Most functional analysis and treatment sessions were conducted in padded session rooms equipped with one-way observation mirrors; some sessions were conducted in nonpadded rooms when padding was not necessary for safety.

Response Measurement

Trained staff observed sessions from behind a one-way mirror and recorded target responses on laptop computers. Data were analyzed using a computer program.

Prior to assessment, target behaviors were defined individually for each participant. SIB included the following topographies: head banging, hand-to-head hitting, self-biting, body slapping or slamming, self-kicking, self-scratching or skin picking, hair pulling, and disconnecting ventilator tube from tracheostomy (Case 23). Aggression included hitting, kicking, pinching, scratching, biting, slapping, hair pulling, grabbing, eye poking, head butting, spitting, verbal aggression, choking, and throwing objects within 1 ft of another person. Disruptive behavior included throwing objects, swiping objects off surfaces, banging on surfaces, breaking or tearing objects, and kicking objects. Dangerous behavior included climbing or jumping on or off furniture, touching electrical sockets or heater vents, banging on windows, and climbing on windowsills. Elopement, pica, and object mouthing were included as target behaviors in some cases. Most participants exhibited other topographies of problem behavior in addition to SIB; therefore, the term *problem behavior* will be used hereafter to include SIB plus other target behaviors. Finally, data were collected on frequency of communication responses for those cases in which treatments included FCT.

Procedural integrity data were collected on caregiver implementation of functional analysis contingencies. Correct implementation during test conditions was defined as provision of the specified consequence within 5 s of a target behavior. If the caregiver failed to respond to the child's target behavior within 5 s, an incorrect response was scored, and a prompt to respond was provided by the trainer. Similarly, if a caregiver

Table 1
Demographic Characteristics of Participants

Case	Age of SIB onset (years–months)	Age at start of services (years–months)	Medical diagnosis	Level of functioning
1	0–8	3–5	None	Mild mental retardation
2	3–0	3–8	Cerebral palsy	Developmental delay
3	1–6	3–9	Moebius syndrome	Profound mental retardation
4	1–0	2–5	None	Developmental delay
5	0–8	2–5	None	Average
6	1–0	1–2	None	Developmental delay
7	0–11	2–0	Minor neuromotor abnormalities	Developmental delay
8	0–11	1–8	Paraneoplastic syndrome resulting from neuroblastoma	Developmental delay
9	1–0	2–10	Postasphyxial encephalopathy with autistic tendencies	Developmental delay
10	1–3	4–2	Cardio-facio-cutaneous syndrome	Severe mental retardation
11	2–0	4–11	Fetal alcohol syndrome	Mild mental retardation
12	2	2–10	ADHD	Average
13	0–9	0–10	Neonatal abstinence syndrome	Average
14	2–6	3–4	Autistic disorder	Moderate mental retardation
15	1–2	1–6	Insomnia	Average
16	2–6	2–9	Smith-Lemli-Opitz syndrome	Not identified
17	1–0	2–10	Lead poisoning	Mild mental retardation
18	1–6	2–10	None	Average
19	2–6	4–4	Seizure disorder	Mild mental retardation
20	2–0	3–11	ADHD	Mental retardation unspecified
21	0–1	2–8	None	Moderate mental retardation
22	1–10	2–5	None	Average
23	1–4	1–9	Respiratory disorder	Profound mental retardation
24	0–9	1–5	None	Average
25	2–6	4–3	Kleinfelter's syndrome	Average
26	1–0	2–10	Traumatic brain injury	Severe mental retardation
27	1–0	3–3	Cerebral palsy	Moderate mental retardation
28	1–0	1–11	None	Average
29	1–0	2–3	Chromosome 9 and 13 translocation	Moderate mental retardation
30	2–6	3–4	Trisomy 18 syndrome	Not identified

responded to a nontarget behavior, an incorrect response was scored, and corrective feedback was provided immediately. Correct implementation in the play (control) condition was scored if the caregiver ignored a child's problem behavior, whereas an incorrect response was scored if the caregiver responded to a child's problem behavior (e.g., provided verbal attention or eye contact).

General Procedure

Prior to assessment, historical data were collected for each participant. Medical and educational records were reviewed, and structured interviews were conducted with caregivers to obtain participants' behavioral histories, including age of SIB onset, first topography of SIB observed, circumstances surrounding SIB onset, and types of services previously sought to address SIB.

The overall course of assessment and treatment for each participant typically included a preference assessment to identify potential reinforcers (e.g., Fisher et al., 1992; Piazza et al., 1998), a functional analysis (Iwata et al., 1982/1994), and the evaluation of a reinforcement-based intervention via single-subject design. If necessary, a stimu-

lus-avoidance assessment (Fisher, Piazza, Bowman, Hagopian, & Langdon, 1994) was also conducted to identify potential punishment procedures. Upon completion of the treatment evaluation phase, caregiver training sessions were conducted.

General Characteristics of and Modifications to Functional Analysis Procedures

Although the focus of this study was SIB, most participants exhibited additional forms of problem behavior; therefore, contingencies were applied to all forms of problem behavior during functional analysis sessions. A number of modifications to the procedures of Iwata et al. (1982/1994) were made to accommodate the developmental level of the participants, the novelty of the clinic environment, the presence of strangers, and the 2- to 3-hr duration of each clinic visit. In most cases, a multielement design was used, wherein at least three test conditions (e.g., demand, attention, and tangible) and a control condition (toy play) were alternated. A sequential test–control methodology (Iwata, Duncan, Zarcone, Lerman, & Shore, 1994) was used with 6 participants (Cases 3, 10, 13, 23, 24, and 29) to facilitate discrimination of the various conditions. Most sessions were 10 min in duration; for 1 child (Case 16) all sessions were 5 min due to the severity of her self-injury and tantrums.

Training of caregivers as therapists. Because many children showed significant stress when separated from their caregivers, primary caregivers were trained to serve as therapists during functional analyses for 21 of the 30 participants (70% of cases). Clinic staff served as therapists for the remaining 9 participants. Training followed a five-step model similar to that described by Iwata et al. (2000). Caregivers were first given written descriptions of each condition, and then observed videotaped sessions of each condition. Role playing of each condition, with the trainer providing feedback, followed; then, the child's functional analysis was initiated with the caregiver serving as therapist. The trainer remained in the session room for the first session of each condition to supervise implementation of the contingencies. If the caregiver correctly implemented the contingencies, the trainer left, and the caregiver independently conducted the remainder of the sessions. If the caregiver did not meet the criterion of 90% correct implementation across one session of each condition, feedback was provided until the criterion was reached. In some cases, it was necessary for the trainer to remain in the room until the functional analysis was completed.

Condition-specific modifications. Functional analyses were conducted as described by Iwata et al. (1982/1994) (the reader is referred to this article for a detailed description of the procedures). A tangible condition was included for many participants, and is described below. Case-specific variations for each assessment condition were made as follows:

The attention condition was modified to simulate the type of attention that was typically provided by the participant's caregiver. Thirteen participants (Cases 3, 5, 6, 9, 13, 14, 16, 23, 24, 25, 27, 29, and 30) received 10 to 30 s of verbal and physical attention (e.g., providing comforting and soothing statements, picking up and holding the child, rocking the child) contingent on problem behavior. Also, a divided-attention condition (Mace, Page, Ivancic, & O'Brien, 1986) was presented for 9 participants (Cases 4, 6, 7, 12, 15, 16, 17, 21, and 28), wherein two adults engaged in conversation apart from the child. One adult delivered a brief verbal reprimand to the child contingent upon problem behavior. Finally, a caregiver-return condition was presented for 3 participants (Cases 9, 12, and 20), wherein the caregiver attempted to leave the room but returned to deliver a brief verbal reprimand contingent on problem behavior.

Two types of modifications were made to the demand condition. First, 1 participant (Case 25) was allowed to watch television contingent on problem behavior, because this was the typical response at home when the child exhibited noncompliance and problem behavior. Second, activities of daily living (ADL) such as dressing, hair brushing, and face washing were presented to 5 participants who had never been exposed to preacademic tasks (Cases 6, 13, 14, 15, and 24). The therapist announced the activity (e.g., "it is time to brush your hair") and completed the activity for the child. A new ADL was presented every 2 min. Praise for compliance was provided when each ADL was completed. The child received 30 s of escape from the activity contingent on problem behavior.

Because many caregivers reported that they never left their young children alone, an alone condition was not included unless an automatic function for SIB was hypothesized. This condition was included for 7 participants (Cases 17, 18, 19, 22, 26, 27, and 30). One child's (Case 30) alone sessions were 5 min long due to the severity of his SIB and tantrums.

In the play condition, the therapist provided continuous adult attention (e.g., physical attention, therapist's manipulation of toys) for 13 participants (2, 3, 4, 6, 13, 14, 21, 23, 24, 25, 28, 29, and 30) to simulate the quality of attention delivered by the caregiver.

Finally, a tangible condition was included for most participants. For 2 min prior to the start of the session, a preferred tangible item (as identified in the preference assessment) was available. At the start of the session, this item was withdrawn from the child; contingent on the occurrence of problem behavior, the item was returned for 30 s. The variation made to this condition for some participants involved the adult pairing a phrase, such as "it's my turn," with the removal of the item.

Treatment Analyses

Individualized interventions were developed for 24 of 30 participants (80%) based on results of the functional analyses. Of the 6 remaining participants, 4 families (Cases 15, 16, 18, and 20) terminated services for varying reasons, and clinic services were terminated for 1 participant (Case 17) due to inconsistent attendance. One child's (Case 22) problem behavior was extinguished following an undifferentiated functional analysis; thus, the family was provided with recommendations for behavior management and offered consulting services.

Individual treatment evaluations were conducted using reversal or multiple baseline designs. Sessions were 10 min in duration, except for Case 30, whose sessions were 5 min. Treatments were implemented in assessment conditions that had been shown to maintain problem behavior. Reinforcement-based treatments were initiated, and the goal for each participant was to achieve at least an 80% reduction in problem behavior. If this goal was not achieved, a stimulus-avoidance assessment was conducted with caregiver approval, and a punishment component was added to the treatment package. The percentage reduction obtained with each treatment was calculated by subtracting the mean rate (number of responses per minute) of the last five sessions of the final treatment phase from the mean rate during the initial baseline phase, dividing that number by the mean rate during the initial baseline phase, and multiplying by 100%.

Most caregivers who served as therapists in the functional analysis also served as therapists in the treatment evaluation and received training prior to initiating treatment with their children. When staff served as therapist during treatment evaluations, caregivers were trained to implement the treatments following completion of the evaluations. Training procedures for caregivers

consisted of a discussion of treatment rationale, observation of staff implementation of treatment procedures, modeling and role playing with staff, and sequential implementation of treatment components.

For participants who received FCT-based treatments, communication responses (e.g., verbal, picture exchange) were individually selected. Training in the communication response was conducted prior to the treatment evaluation, using either an errorless backward-chaining procedure (Hagopian, Fisher, Sullivan, Acquisto, & LeBlanc, 1998) or a prompt-delay procedure (Charlop, Schreibman, & Thibodeau, 1985). After training, the treatment evaluation began with FCT plus extinction.

Interobserver Agreement and Procedural Integrity

Reliability data were collected for a mean of 55% of functional analysis sessions (range, 11.4% to 94%). Mean exact agreement coefficients for SIB and problem behavior (SIB plus other target behaviors) were 97% (range, 88.5% to 100%) and 98% (range, 93.6% to 100%), respectively.

Reliability data for problem behavior were collected for 23 of the 24 participants who received function-based treatments for a mean of 35.3% of sessions (range, 2.2% to 100%). Mean exact agreement coefficients for SIB and problem behavior were 95.3% (range, 65.6% to 100%) and 97.9% (range, 77.4% to 100%), respectively. Reliability data for FCT responses were collected for 16 of the 17 participants who received FCT-based treatments for a mean of 37.8% of sessions. The mean exact agreement coefficient was 96.3% (range, 88.6% to 99.1%).

Finally, procedural integrity data were collected for 8 of the 21 caregiver-conducted functional analyses for an average of 72.3% of sessions (range, 24% to 100%). Procedural integrity was calculated on a session-by-session basis by dividing the frequency of correct responses by the sum of the frequency of correct plus incorrect responses. Caregivers' correct implementation of contingencies averaged 73% (range, 33% to 94%). Reliability data for caregivers' correct and incorrect implementation of functional analysis contingencies were collected for a mean of 49.9% of these sessions (range, 32% to 83%). Mean exact agreement coefficients for correct implementation and incorrect implementation were 97.3% (range, 92.2% to 100%) and 99.2% (range, 99% to 100%), respectively.

RESULTS

Behavioral Histories

The mean age of SIB onset was 17 months (range, 1 to 36 months) across the 30 participants. Caregivers reported head banging as the first topography of SIB exhibited for 70% of participants. Hand-to-head SIB (10%), self-biting (6.7%), body slapping (3.3%), body slamming (3.3%), and scratching (3.3%) were the first topographies observed for the remaining participants. One participant's caregiver was unable to report the first topography of SIB observed. With regard to circumstances surrounding the first occurrence of SIB, almost half (14) the caregivers did not identify any initial circumstances; the other half reported a variety of physiological and environmental conditions. Over half the participants' families had sought services previously to address their child's SIB (e.g., medical evaluations, outpatient therapy). Also, the families of 8 participants sought medication management. Finally, the service delay (interval from age of SIB onset to time of referral to this program) averaged 16 months (range, 1 to 35 months).

Functional Analyses

Table 2 summarizes the distribution of behavioral functions for SIB and problem

Table 2
Summary of Functional Analysis Results

Identified function	SIB (n = 29)		Combined problem behavior (n = 24)	
	Number of subjects	Percentage of cases	Number of subjects	Percentage of cases
Positive reinforcement	11	37.9	15	62.5
Attention	1		2	
Tangible	3		2	
Attention and tangible	7		11	
Negative reinforcement	1	3.4	1	4.2
Positive and negative reinforcement (Attention or tangible and escape)	2	7.0	4	16.6
Automatic reinforcement	4	13.8	1	4.2
Undifferentiated	11	37.9	3	12.5

behavior (SIB plus other target behaviors) for 29 of the 30 participants; one assessment (Case 8) was discontinued at the parent's request due to the severity of tantrums. Functional analysis outcomes for individual participants are presented in Table 3, with functions reported for SIB and problem behavior. SIB was the only problem behavior exhibited by 5 participants (Cases 3, 10, 23, 29, and 30); for the remaining participants, assessment (and subsequent treatment) targeted all forms of problem behavior.

Sources of reinforcement for SIB were identified for 62.1% of cases. SIB was maintained by positive reinforcement in the form of access to attention or tangible items for 37.9% of cases, whereas only 3.4% of cases displayed SIB maintained by negative reinforcement. Both positive and negative reinforcement (multiple control) accounted for 7% of the cases. SIB appeared to be maintained by automatic reinforcement in 13.8% of cases; of these, rates of SIB were highest in the alone condition for 2 participants (Cases 27 and 30) and were high across all conditions (including the play condition) for 2 participants with whom an alone condition was not conducted (Cases 3 and 23). Finally, results were undifferentiated for 11 cases (37.9%); however, further inspection of the data revealed that 8 of these participants exhibited near-zero rates of SIB, with higher rates and differentiated outcomes for problem behavior (SIB plus other target behaviors).

Sources of reinforcement for all problem behavior were identified in 87.5% of cases. Over 60% of participants exhibited problem behavior that was maintained by positive reinforcement. Only 1 child (4.2%) displayed problem behavior maintained by negative reinforcement alone, whereas 4 participants (16.6%) exhibited problem behavior that was multiply controlled. One child (4.2%) displayed SIB and disruptive behavior maintained by automatic reinforcement. Functional analysis results for 3 participants (12.5%) were undifferentiated; however, subsequent analyses were conducted to identify behavioral function with 2 of these participants and with the child whose functional analysis was not completed.

Treatment Analyses

Table 3 also lists the interventions that were implemented, and the mean percentage reductions achieved for SIB and for problem behavior (SIB plus other target behaviors) for the 24 children who completed treatment. Averaged across participants, rates of

Table 3
Results of Functional Analyses, Prescribed Interventions, and Percentage Reductions for Problem Behavior

Case	Results of functional analysis		Treatment	% Reduction	
	SIB	Combined problem behavior		SIB	Combined problem behavior
1	Undifferentiated	Attention, tangible	FCT + punishment + DRO	100.0	99.7
2[a]	Tangible	Tangible	FCT + punishment	94.0	29.6
3[a]	Automatic		NCR + protective equipment	98.5	
4[a]	Undifferentiated	Undifferentiated[b]	FCT + punishment	100.0	95.9
5[a]	Tangible	Attention, tangible	FCT + punishment + DRO	77.0	76.8
6[a]	Divided attention, tangible	Divided attention, tangible	NCR	100.0	100.0
7	Undifferentiated	Divided attention, tangible	FCT + punishment	100.0	89.4
8[a]	Assessment incomplete	Assessment incomplete[b]	FCT + extinction	91.0	
9[a]	Attention, tangible, escape	Attention, tangible, escape	FCT + extinction	98.0	98.6
10[a]	Attention, tangible		FCT + extinction	95.0	
11	Divided attention	Undifferentiated[b]	FCT + punishment + DRO	100.0	94.0
12[a]	Tangible, caregiver return	Tangible, caregiver return	FCT + extinction + DRO	99.5	99.5
13[a]	Attention, tangible	Attention, tangible, escape	Attention and tangible: FCT + extinction Escape: NCR + DRO	95.2	94.3
14[a]	Escape	Escape	NCR	85.2	70.4
15	Undifferentiated	Divided attention, escape			
16[a]	Attention, tangible	Attention, tangible			
17	Undifferentiated	Divided attention			
18	Undifferentiated	Attention			
19[a]	Tangible	Tangible	FCT + punishment	89.0	62.8
20[a]	Undifferentiated	Attention, tangible, mands			
21[a]	Divided attention, tangible	Divided attention, tangible	Divided attention: NCR + punishment Tangible: FCT + extinction	74.5	82.2
22	Undifferentiated	Undifferentiated			
23[a]	Automatic		NCR + protective equipment	100.0	
24[a]	Attention, tangible	Attention, tangible	FCT + extinction	99.2	94.4
25[a]	Undifferentiated	Attention, tangible, escape	Levels treatment	100.0	98.0
26	Undifferentiated	Attention, tangible	FCT + punishment	100.0	99.7
27	Automatic	Automatic	NCR, blocking SIB, extinction for other target behaviors, and activity schedule	96.9	
28[a]	Undifferentiated	Attention, divided attention, tangible	FCT + extinction	100.0	93.0
29[a]	Caregiver return, attention, tangible, escape		FCT + punishment + NCR	89.7	
30[a]	Automatic		NCR	100.0	

[a] Caregiver served as therapist for the functional analysis.
[b] Secondary analyses were conducted to identify behavioral function.

SIB and problem behavior were reduced from baseline rates by 95% (range, 74.5% to 100%) and 87% (range, 29.6% to 100%), respectively. Our typical treatment goal is to reduce aberrant behavior by at least 80%, and this criterion was met for 91.7% and 76% of cases for SIB and problem behavior, respectively.

The most frequently prescribed intervention, FCT, was used for 17 of 24 participants (70.8%). Overall, FCT-based treatments resulted in a mean behavioral reduction of 94.8%. The problem behavior of 8 participants was successfully treated using FCT plus extinction, whereas 9 participants required a punishment component in addition to FCT to achieve acceptable reductions. In addition, FCT-based treatments for 4 participants required a differential reinforcement (DRO) component, and 1 child's treatment included a noncontingent reinforcement (NCR) component.

In some cases, participants whose problem behavior was multiply controlled required two different treatment packages. Specifically, Case 13 had FCT plus extinction for his attention and tangible functions and NCR plus DRO to address the escape function. For Case 21, FCT plus extinction was used for tangible situations, whereas NCR plus punishment effectively reduced problem behavior during divided-attention situations.

For the remaining 7 participants, treatments other than FCT-based interventions were effective. NCR plus protective equipment was prescribed for 2 participants whose problem behavior was maintained by automatic reinforcement. A levels treatment (Hagopian et al., 2002) effectively reduced rates of multiply controlled problem behavior for 1 child. Interventions for the problem behavior of 3 children included NCR. Finally, treatment consisted of NCR, blocking of SIB, extinction for other problem behavior, and a time-based activity schedule for 1 child with low-rate and low-intensity SIB.

Thirteen of 24 cases were successfully treated without punishment. One interesting finding with regard to the use of punishment concerned the relation between service delay and treatment selection. Participants were divided into three groups: short service delay (less than 12 months, $n = 10$), moderate service delay (12 to 23 months, $n = 7$), and long service delay (24 months or more, $n = 7$). Of the cases with short service delay, only 1 child (Case 2; 10%) had a treatment package that included punishment. In contrast, punishment procedures were necessary to achieve behavioral reductions in 57.1% of cases in the moderate-delay group and in 85.7% of cases in the long-delay group.

DISCUSSION

In the current study, functional analyses were conducted with 29 young children with SIB and other severe behavior problems. The methodology was flexible enough to permit procedural changes based on each child's developmental level. Even with modifications, such as using caregivers as therapists, changing the structure of demands, modifying the quality of attention, and eliminating the alone condition, operant functions for SIB and other problem behavior were identified in over 87% of cases. Interventions based on functional analysis results were effective, resulting in overall reductions of 95% for SIB and 87% for problem behavior.

Our results demonstrate that for very young children in the early stages of the disorder, SIB, as well as other forms of problem behavior, appear to be maintained primarily by social reinforcement. In the present study, 48.3% of cases with SIB and 83.3% of cases with problem behavior were socially maintained. These findings are consistent with those of previous investigations that used relatively large sample sizes (e.g., Derby et al., 1992; Iwata, Pace, et al., 1994, Wacker et

al., 1998). Iwata, Pace, et al. found that 69.7% of cases of SIB were maintained by social reinforcement; similarly, Wacker et al. reported that 85.7% of children exhibited problem behavior maintained by social variables. However, some important differences between the results of these studies and the present findings should be noted. First, in contrast to previous findings that social-negative reinforcement was most prevalent, the majority of participants in the present study exhibited SIB and problem behavior maintained primarily by social-positive reinforcement (38% for SIB and 64% for problem behavior). This difference may be due in part to the young age of our participants, because their typical daily environment consisted mostly of interaction with caregivers and toys, with limited exposure to demands. At this developmental stage, young children are likely to find parental attention and toys to be very potent reinforcers. It may be that as children age and the demands placed on them increase, escape can acquire reinforcing properties. In particular, entry into school programs, with their emphasis on formal training, may represent an experience in which escape behavior is more likely to emerge. Therefore, problem behavior maintained by negative reinforcement may be more likely in older children.

The current findings also differ from those reported by Iwata, Pace, et al. (1994) in that a larger percentage of cases in the present study had undifferentiated results for functional analyses of SIB. In the majority of cases, this was due to low rates of responding by our participants. It is possible that other problem behaviors belonged to the same response class as SIB, and that reinforcing all topographies of problem behavior might have had the unintended effect of reducing SIB (Richman, Wacker, Asmus, Casey, & Andelman, 1999). Eight of the 11 children who exhibited low rates of SIB displayed higher levels of other problem behaviors whose functions were identified during assessment. Whether these cases reflected response class interactions is unknown but could be tested by sequentially placing each targeted topography on extinction (e.g., Magee & Ellis, 2000).

That 48% of participants displayed SIB maintained by social reinforcement is of importance in light of their very young ages and relatively recent onset of SIB. In previous observational studies of emerging SIB (e.g., Hall et al., 2001; Murphy et al., 1999), no environmental variables were correlated with the development of the disorder. It is possible, however, that observations were conducted too early in the development of the behavior for environmental functions to be identified, or that descriptive analysis procedures were not sensitive enough to detect a function. In addition, the participants were from a nonreferred population. In contrast, participants in the present study were from a clinically referred population with longer histories of SIB and consequent tissue damage. Although the intent of the present study was not to examine the emergence of SIB per se, the functional analysis results do support the notion that operant processes play an important role in the early development of this disorder.

Our findings on service delay suggested that participants with the longest delay to treatment may be more likely to require use of punishment to reduce problem behavior. Although intervening earlier may have resulted in a reduced need for punishment for some children, there are several alternative explanations. It is possible that extinction may have been effective; however, some caregivers may have been unable to implement this procedure consistently. Furthermore, it may have been easier for participants to discriminate consequences for problem behavior when punishment rather than extinction was applied. Finally, it is possible that extinction was less effective because problem

behavior and alternative responses (e.g., FCT) had become members of the same response class. Indeed, use of punishment in conjunction with FCT has been found to be more effective than using FCT alone or with extinction (Fisher et al., 1993; Hagopian et al., 1998).

Results of the current study have important implications for the assessment and treatment of SIB. First, the finding that the majority of participants exhibited multiple topographies of SIB as well as other forms of problem behavior at a young age suggests that early identification and treatment are critical. Although much remains to be learned about the etiology and developmental course of SIB, intervening before a lengthy history of reinforcement has been established seems prudent. Given the efficacy of functional analysis and function-based treatment demonstrated in the current investigation, future clinical and research efforts should focus on early identification of children who exhibit SIB, use of functional analysis as an initial assessment tool consistent with best practice procedures, and evaluation of function-based interventions.

Second, given the strong environmental influences on early problem behavior, the successful inclusion of caregivers in the assessment and treatment process may be important because parents and teachers are the primary agents of behavior change for young children. In the present study, most caregivers were trained to implement functional analysis procedures relatively quickly. However, the relative advantages of using a caregiver instead of an unfamiliar therapist were not directly assessed. At least one previous study (Ringdahl & Sellers, 2000) suggests that the inclusion of caregivers as therapists may influence the results of functional analyses. In addition, most parents in the present study appeared to gain a better understanding of behavior analysis in general, and of their child's problem behavior in particular, when they participated directly in the assessment and treatment process. Certainly, these observations could be tested to evaluate the effects of behavioral rehearsal.

Our results on the efficacy of FCT-based interventions are consistent with those of Hagopian et al. (1998) and contribute to the growing number of studies (e.g., Reeve & Carr, 2000; Wacker et al., 1998) that have reported the utility of FCT with young children. It should be noted, however, that although FCT was the treatment prescribed most often for this group, it is possible that other reinforcement-based interventions, such as DRO or NCR, may have been equally effective. Furthermore, all FCT-based treatments were combined with extinction, punishment, or another DRO procedure; therefore, it is not clear which of these components was responsible for the behavior reductions. Despite these considerations, the teaching of communication is not only useful from a treatment standpoint but is especially appropriate for children at risk for language delays or developmental disabilities. Indeed, results of studies that have examined long-term use of FCT (Derby et al., 1992; Reeve & Carr, 2000; Wacker et al., 1998) suggest that FCT may affect the areas of prevention, early intervention, and long-term outcome.

Limitations to the present study should be noted. First, as previously mentioned, participants were taken from a clinically referred population of children whose severity of SIB warranted intensive behavioral treatment. The level of functioning of some participants appeared to be higher than that typically found in individuals with chronic SIB; thus, the generality of the present results is unknown. Second, functional analysis outcomes may have differed if SIB had been the only behavior of interest. However, it was not clinically justifiable to provide contingencies for SIB only, because most children exhibited multiple forms of problem behav-

ior. Third, because data were not collected on caregivers' implementation of antecedent events during functional analyses, incorrect procedural implementation may have affected assessment outcomes. Fourth, variables outside our experimental control may have confounded individual assessments. For example, medication manipulations were conducted concurrently with the behavioral assessment and treatment process for some participants. Fifth, although information on the backgrounds of these young children may contribute to our understanding of SIB, the use of historical data based on caregiver report presents some concerns. For example, it was not possible to verify the accuracy of information provided by caregivers or presented in previous medical and educational reports. Finally, generalization and follow-up data were not included in this study. Although generalization data collected for 12 participants indicated maintenance of behavior reductions in natural settings, more systematic assessment is needed.

The participants in this study had been referred for severe SIB at very early ages. At the start of intensive treatment, almost 90% of them already displayed multiple topographies of SIB as well as other forms of problem behavior. At that point, an emerging behavior problem had become a severe behavior disorder. This suggests at least two specific areas for future research. First, the influences of biological and developmental factors in the emergence of SIB must be clarified. Although theoretical accounts (e.g., Cataldo & Harris, 1982; Guess & Carr, 1991; Schroeder et al., 2001) have been proposed, to date there are no conclusive supporting data. A second area of needed research is in direct observation and treatment during the earliest stages of SIB. Future studies in this area should emphasize the identification of children most at risk, analyses of environmental variables, and intervention before the behavior becomes high risk. Use of such strategies before a long behavioral history develops may promote treatments that are simpler and less intrusive, and may prevent the emergence of other topographies of SIB and other problem behavior. In addition, such early intervention may decrease the utilization of more intensive and more costly services. With the refinement of comprehensive assessment and treatment models for emerging SIB, it is hoped that it may be possible to prevent the development of SIB and other severe behavior problems.

REFERENCES

Berkson, G., Tupa, M., & Sherman, L. (2001). Early development of stereotyped and self-injurious behaviors: I. Incidence. *American Journal on Mental Retardation, 106,* 539–547.

Cataldo, M. F., & Harris, J. (1982). The biological basis for self-injury in the mentally retarded. *Analysis and Intervention in Developmental Disabilities, 2,* 21–39.

Charlop, M. H., Schreibman, L., & Thibodeau, M. G. (1985). Increasing spontaneous verbal responding in autistic children using a time delay procedure. *Journal of Applied Behavior Analysis, 18,* 155–166.

de Lissovoy, V. (1962). Head banging in early childhood. *Child Development, 33,* 43–56.

Derby, K. M., Wacker, D. P., Sasso, G., Steege, M., Northup, J., Cigrand, K., et al. (1992). Brief functional assessment techniques to evaluate aberrant behavior in an outpatient setting: A summary of 79 cases. *Journal of Applied Behavior Analysis, 25,* 713–721.

Fisher, W., Piazza, C. C., Bowman, L. G., Hagopian, L. P., & Langdon, N. A. (1994). Empirically derived consequences: A data-based method for prescribing treatments for destructive behavior. *Research in Developmental Disabilities, 15,* 133–149.

Fisher, W., Piazza, C. C., Bowman, L. G., Hagopian, L. P., Owens, J. C., & Slevin, I. (1992). A comparison of two approaches for identifying reinforcers for persons with severe and profound disabilities. *Journal of Applied Behavior Analysis, 25,* 491–498.

Fisher, W., Piazza, C., Cataldo, M., Harrell, R., Jefferson, G., & Conner, R. (1993). Functional communication training with and without extinction and punishment. *Journal of Applied Behavior Analysis, 26,* 23–36.

Guess, D., & Carr, E. (1991). Emergence and maintenance of stereotypy and self-injury. *American Journal on Mental Retardation, 96,* 299–319.

Hagopian, L. P., Fisher, W. W., Sullivan, M. T., Acquisto, J., & LeBlanc, L. A. (1998). Effectiveness of functional communication training with and without extinction and punishment: A summary of 21 inpatient cases. *Journal of Applied Behavior Analysis, 31,* 211–235.

Hagopian, L. P., Rush, K., Richman, D. M., Kurtz, P. F., Contrucci, S. A., & Crosland, K. (2002). The development and application of individualized levels systems for the treatment of severe problem behavior. *Behavior Therapy, 33,* 65–86.

Hall, S., Oliver, C., & Murphy, G. (2001). Early development of self-injurious behavior: An empirical study. *American Journal on Mental Retardation, 106,* 189–199.

Iwata, B. A., Dorsey, M. F., Slifer, K. J., Bauman, K. E., & Richman, G. S. (1994). Toward a functional analysis of self-injury. *Journal of Applied Behavior Analysis, 27,* 197–209. (Reprinted from *Analysis and Intervention in Developmental Disabilities, 2,* 3–20, 1982)

Iwata, B. A., Duncan, B. A., Zarcone, J. R., Lerman, D. C., & Shore, B. A. (1994). A sequential, test-control methodology for conducting functional analyses of self-injurious behavior. *Behavior Modification, 18,* 289–306.

Iwata, B. A., Pace, G. M., Dorsey, M. F., Zarcone, J. R., Vollmer, T. R., Smith, R. G., et al. (1994). The functions of self-injurious behavior: An experimental-epidemiological analysis. *Journal of Applied Behavior Analysis, 27,* 215–240.

Iwata, B. A., & Rodgers, T. A. (1992). Self-injurious behavior. In E. A. Konarski, J. E. Favell, & J. E. Favell (Eds.), *Manual for the assessment and treatment of the behavior disorders of people with mental retardation* (pp. 1–18). Morganton, NC: Western Carolina Center Foundation.

Iwata, B. A., Wallace, M. D., Kahng, S., Lindberg, J. S., Roscoe, E. M., Conners, J., et al. (2000). Skill acquisition in the implementation of functional analysis methodology. *Journal of Applied Behavior Analysis, 33,* 181–194.

Jacobson, J. W., Mulick, J. A., & Green, G. (1998). Cost-benefit estimates for early intensive behavioral intervention for young children with autism—general model and single state case. *Behavioral Interventions, 13,* 201–226.

Lovaas, O. I. (1987). Behavioral treatment and normal educational and intellectual functioning in young autistic children. *Journal of Consulting and Clinical Psychology, 55,* 3–9.

Mace, F. C., Page, T. J., Ivancic, M. T., & O'Brien, S. (1986). Analysis of environmental determinants of aggression and disruption in mentally retarded children. *Applied Research in Mental Retardation, 7,* 203–221.

Magee, S. K., & Ellis, J. (2000). Extinction effects during the assessment of multiple problem behaviors. *Journal of Applied Behavior Analysis, 33,* 313–316.

McEachin, J. J., Smith, T., & Lovaas, O. I. (1993). Long-term outcome for children with autism who received early intensive behavioral treatment. *American Journal of Mental Retardation, 97,* 359–372.

Murphy, G., Hall, S., Oliver, C., & Kissi-Debra, R. (1999). Identification of early self-injurious behavior in young children with intellectual disability. *Journal of Intellectual Disability Research, 43,* 149–163.

National Institutes of Health, Consensus Development Panel on Destructive Behaviors in Persons with Developmental Disabilities. (1989). *Treatment of destructive behaviors in persons with developmental disabilities* (NIH Publication No. 91-2410). Bethesda, MD: U.S. Department of Health and Human Services.

Pelios, L., Morren, J., Tesch, D., & Axelrod, S. (1999). The impact of functional analysis methodology on treatment choice for self-injurious and aggressive behavior. *Journal of Applied Behavior Analysis, 32,* 185–195.

Piazza, C. C., Fisher, W. W., Hanley, G. P., LeBlanc, L. A., Worsdell, A. S., Lindauer, S. E., et al. (1998). Treatment of pica through multiple analyses of its reinforcing functions. *Journal of Applied Behavior Analysis, 31,* 165–189.

Ramey, C. T., & Campbell, F. A. (1992). Poverty, early childhood education, and academic competence: The Abcedarian Project. In A. Houston (Ed.), *Children in poverty* (pp. 190–221). Cambridge, England: Cambridge University Press.

Reeve, C. E., & Carr, E. G. (2000). Prevention of severe behavior problems in children with developmental disorders. *Journal of Positive Behavior Interventions, 2,* 144–160.

Richman, D. M., Wacker, D. P., Asmus, J. M., Casey, S. D., & Andelman, M. (1999). Further analysis of problem behavior in response class hierarchies. *Journal of Applied Behavior Analysis, 32,* 269–283.

Ringdahl, J. E., & Sellers, J. A. (2000). The effects of different adults as therapists during functional analyses. *Journal of Applied Behavior Analysis, 33,* 247–250.

Romanczyk, R. G., Kistner, J. A., & Plienis, A. (1982). Self-stimulatory and self-injurious behavior: Etiology and treatment. In J. J. Steffan & P. Karoly (Eds.), *Advances in child behavior analysis and therapy* (pp. 189–254). Lexington, MA: Lexington Books.

Sallustro, F., & Atwell, C. W. (1978). Body rocking, head banging, and head rolling in normal children. *Journal of Pediatrics, 93,* 704–708.

Schneider, M. J., Bijam-Schulte, A. M., Janssen, C. G. C., & Stolk, J. (1996). The origin of self-injurious behavior of children with mental retar-

dation. *British Journal of Developmental Disabilities, 42,* 136–148.
Schroeder, S. R., Oster-Granite, M. L., Berkson, G., Bodfish, J. W., Breese, G. R., Cataldo, M. F., et al. (2001). Self-injurious behavior: Gene-brain-behavior relationships. *Mental Retardation and Developmental Disabilities Research Reviews, 7,* 3–12.
Wacker, D. P., Berg, W. K., Harding, J. W., Derby, K. M., Asmus, J. M., & Healy, A. (1998). Evaluation and long-term treatment of aberrant behavior displayed by young children with developmental disabilities. *Developmental and Behavioral Pediatrics, 19,* 260–266.

Received August 12, 2002
Final acceptance February 21, 2003
Action Editor, Brian Iwata

STUDY QUESTIONS

1. Describe the procedural integrity data that were taken during functional analysis sessions conducted by caregivers.

2. Why were parents used as therapists in a majority of cases, and how were they trained?

3. What were some of the modifications the authors made to the attention condition to accommodate the young age of the participants?

4. Under what conditions was a stimulus-avoidance assessment conducted?

5. What was the most prevalent function of the problem behavior, and to what did the authors attribute this finding?

6. What relationship did the authors observe between participants' delay to services and the use of punishment procedures in treatment?

7. What were the most frequently used interventions in this study?

8. How might the exclusion of the alone condition in the majority of cases have affected the results of the functional analyses?

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