

*FUNCTIONAL ANALYSIS AND TREATMENT OF SELF-INJURY IN A
CAPTIVE OLIVE BABOON*

NICOLE R. DOREY, JESÚS ROSALES-RUIZ, RICHARD SMITH, AND BRYAN LOVELACE

UNIVERSITY OF NORTH TEXAS

Self-injurious behavior (SIB), such as self-biting and head banging, has been reported to occur in approximately 10% of captive, individually housed nonhuman primates. Accounts of the etiology of SIB in primates range from ecological to physiological. However, to date, no research has examined the possible influence of social consequences delivered by handlers and keepers in the maintenance of SIB in this population. The current study investigated the effects of social contact as a potentially reinforcing consequence for the SIB displayed by an olive baboon (*Papio hamadryas anubis*). Results indicated that the behavior was maintained by attention from humans. As treatment, reinforcement was arranged for an appropriate alternative response, resulting in increases in the appropriate alternative behavior and decreases in SIB.

DESCRIPTORS: functional analysis, hair pulling, olive baboon, self-injurious behavior

Self-injurious behavior (SIB) was first documented in primates more than 70 years ago, when Tinklepaugh (1928) reported self-biting in a male *Macaca mulatta* named Cupid. (For the purpose of this discussion, the term *primates* will be used to refer to a population of primates that excludes *homo sapiens*.) Since Tinklepaugh's initial observations, it has been estimated that approximately 10% of captive, individually housed primates engage in some type of SIB (Novak, Kinsey, Jorgensen, & Hazen, 1998). Although most of the literature on SIB in primates comes from laboratory-housed animals, this behavior also has been documented in zoo-housed primates (Bloomsmith, Marr, & Maple, 2007; Hosey & Skyner, 2007). Despite this, little research has been conducted on the maintenance of SIB displayed by zoo-housed primates.

Self-injurious behavior in zoo-housed animals can affect the welfare of the animal and the finances of the institution. Hosey and Skyner (2007) found that of the 35 zoos that responded

to their survey, 24 reported cases of SIB across 16 different species of primates in the British Isles. In two reported cases from that sample, SIB led to the death of a primate, one of which was euthanized by the zoo. In addition to deaths, zoos are faced with the concerns of the visitors who frequent the facility. Visitors are often concerned about what they consider to be unnatural behavior in zoo animals (Morgan, Line, & Markowitz, 1998). Zoological parks with animals that show abnormal behavior (e.g., SIB) face the possibility of losing funds because they are largely public institutions, dependent in part on private donations and membership fees for their revenue (Morgan et al.). Also, SIB in animals may be a sign of poor welfare (Carlstead, 1998); thus, visitors may be likely to attribute these behaviors to institutional variables. In addition to the loss of funding, the facilities may also incur a financial burden by treating the injuries of these animals.

Proposed causes of SIB in primates range from ecological influences to physiological anomalies. For example, the National Research Council (1998) implicated housing a primate alone as a possible ecological variable associated with the onset of SIB (Bellanca & Crockett, 2002; Lutz, Well, & Novak, 2003; Reinhardt & Rossell, 2001). Similarly, Watson (1992)

This study was conducted as a masters thesis by the first author.

Address correspondence to Nicole R. Dorey, Department of Psychology, University of Florida, P.O. Box 112250, Gainesville, Florida 32611 (e-mail: Ndorey@ufl.edu).

doi: 10.1901/jaba.2009.42-785

proposed that inadequate living conditions (e.g., lack of enrichment) could cause SIB and suggested that introducing interesting features into the living quarters (e.g., a puzzle feeder) might reduce occurrences of this behavior. However, Novak *et al.* (1998) found that puzzle feeders had no effect on the occurrence of SIB. Novak (2001) suggested that SIB maybe caused by “early social experiences within the first 2 years of life and with exposure to a larger number of moderately stressful events” (p. 247) and suggested that SIB could be a “coping strategy to reduce arousal” (p. 247). Other proposed causes of SIB include separation from sexual partners (Erwin, Mitchell, & Maple, 1973) and affectionate companions (Chamove, Anderson, & Nash, 1984; Redican & Mitchell, 1973).

In addition to ecological factors, several physiological variables associated with SIB in primates have been reported in the literature. For example, Tiefenbacher, Novak, Jorgensen, and Meyer (2000) reported that low mean plasma cortisol levels were correlated with high rates of self-injurious biting. Eaton *et al.* (1999) indicated that high testosterone levels or other androgens may be associated with SIB and suggested a weekly treatment of cyproterone acetate. Similarly, Macy, Beattie, Morgenstern, and Arnstern (2000) found that a twice-daily dose of guanfacine decreased SIB in 2 animals. They suggested that the drug decreased the high levels of “emotional arousal that commonly accompanies self-biting” (p. 419).

Another variable relevant to the occurrence of SIB in primates is the environmental consequences produced by SIB. This possibility was tested by Schaefer (1970) in a laboratory demonstration in which head banging was shaped through contingent delivery of food reinforcement in 2 rhesus monkeys (*Macaca mulatta*). Although this research and others (e.g., Layng, Andronis, & Goldiamond, 1999) suggest that SIB can be shaped in nonhuman animals, no research has been conducted to

examine the role of naturally occurring consequences in the maintenance of SIB. In captive animals, one potential reinforcer may be the behavior of the caregiver with respect to the primate. For example, caregivers might accidentally reinforce SIB by talking to the animal, delivering food, or giving the animal a toy any time the animal emits the problem behavior. Alternatively, the caregiver can allow an animal to avoid or escape unpleasant events, such as demands or the presence of humans in the enclosure, when SIB occurs. The notion that reactions by keepers and handlers may be involved in the maintenance of SIB in captive animals, although sometimes suspected (e.g., Tinklepaugh, 1928), has not been systematically studied in the extant literature. In fact, contingent human interaction has been characterized as a positive experience for animals (Baker *et al.*, 2004).

Research involving the occurrence of SIB in humans has consistently documented the influence of naturally occurring consequences in the maintenance of this behavior. For example, Lovaas and Simmons (1969) demonstrated that social attention (positive reinforcement) maintained the SIB of children who had been diagnosed with autism and mental retardation. Sailor, Guess, Rutherford, and Baer (1968) showed that self-injurious tantrums could be maintained by escape from difficult instruction (negative reinforcement) in a child. Subsequently, a large and growing body of evidence has shown that the SIB exhibited by humans can be maintained by various reinforcement contingencies. In a large epidemiological study, Iwata *et al.* (1994) found that operant contingencies maintained SIB in approximately 95% of individuals with developmental disabilities.

Within the context of SIB and other topographies of aberrant behavior, the term *functional analysis* (Iwata, Dorsey, Slifer, Bauman, & Richman, 1982/1994) has been applied to a procedure used to identify potential maintaining consequences for problem behavior

in humans. This procedure involves the direct observation and repeated measurements of behavior across a variety of conditions, each of which assesses the role of different reinforcement contingencies in the maintenance of problem behavior. The data obtained from a functional analysis are used to develop a treatment in which the maintaining reinforcement contingencies are manipulated to produce a reduction in problem behavior. To date, functional analyses have been conducted to evaluate the occurrence of problem behavior only in humans. Thus, the present study is the first to incorporate procedures derived from those described by Iwata et al. to study variables that maintained SIB displayed by a nonhuman primate and to use this information to develop a treatment that would reduce its occurrence.

METHOD

Participants and Setting

A 13-year-old female olive baboon (*Papio hamadryas anubis*) named Rafiki participated in this study. Rafiki was approximately 60 cm in length and weighed approximately 14 kg. Rafiki lived in captivity most of her life and had been in her current placement for 12.7 years. She received care at least three times a day, which consisted mostly of feeding and cleaning of her enclosures, but sometimes included play and outreach sessions (i.e., participating in educational events in schools and other public settings). The experimenter was a former keeper at the zoo who requested to help Rafiki based on frequent observations of her SIB. Specifically, Rafiki frequently was observed to bite her arms and legs and pulled the hair on her head and arms, resulting in bald spots. The observers in the experiment were not familiar with Rafiki before the experiment began.

Sessions were conducted at the zoo where Rafiki resided. Rafiki was kept in her enclosure during all phases of the investigation. The enclosure consisted of a concrete slab measuring

3 m by 3 m, which was surrounded by a metal chain-link cage that was 10 m in height. Her enclosure contained a wooden den box, wood tree stump, metal switch cage, a metal bucket encased in concrete that held her water, and a plastic pipe attached to the cage with a spout for drinking.

Because Rafiki was a wild animal that could do serious harm, neither the experimenter nor the observers entered the enclosure during any of the functional analysis or treatment conditions. However, most of the zoo staff were not allowed to enter the enclosure either, so these conditions mimicked Rafiki's daily interactions with most of her caretakers. Thus, during all sessions, the experimenter and observers were positioned 1 m away from Rafiki's enclosure. The observers wore sunglasses so that Rafiki could not see where they were looking. Data were collected on computers using software specially written for the purpose.

Response Measurement and Interobserver Agreement

The duration of hair pulling, hand biting, and foot biting was recorded. *Hair pulling* was defined as any contact between two or more fingers and Rafiki's hair that either resulted in the removal of the hair from the root or raised skin. The duration of hair pulling was recorded from the moment her fingers grasped the hair until her fingers released the hair. Olive baboons do groom with their hands; however, this is normally done by sweeping the fingers through the hair in a sideways movement, not by pulling the hair upward and out. *Hand biting* was defined as any part of either hand breaking the plane of the lips. The duration of hand biting was recorded from the moment the hand broke the plane of the lips until it left the plane of the lips. *Foot biting* was defined as any part of either foot or leg breaking the plane of the lips. The duration of foot biting was recorded from the moment the foot broke the plane of the lips until it left the plane of the lips.

In addition to SIB, data were collected on three additional behaviors that could be reinforced as an alternative to SIB during treatment. Following initial observations, two of the additional behaviors (basic grunts and alarm calling) occurred at near-zero levels. Thus, lip smacking was identified as a possible alternative response. *Lip smacking* was defined as the tongue moving between partially closed upper and lower lips, which resulted in a sound. The duration of lip smacking was recorded from the moment the tongue moved between the closed upper and lower lips accompanied by a sound until the mouth movement and the sound stopped for 1 s.

Data on all topographies of SIB and lip smacking were analyzed by calculating the percentage of session time in which the behavior occurred. Specifically, the cumulative duration of each response from each condition was divided by the total session length (i.e., 600 s) and then converted to a percentage of occurrence for each condition.

Interobserver agreement was assessed by comparing the records of two observers who simultaneously but independently scored 41% of the sessions. Interobserver agreement coefficients were calculated for each session and each target behavior by dividing the shorter duration measure by the longer duration measure and converting the result to a percentage. The outcomes were then summarized across sessions. Mean interobserver agreement was 97% (range, 94% to 100%) for hair pulling, 98% (range, 97% to 100%) for foot biting, 98% (range, 96% to 100%) for hand biting, and 93% (range, 90% to 100%) for lip smacking.

Procedure

Functional analysis. To identify potential maintaining consequences for SIB, five conditions were alternated in a random order in a multielement design (ignore, attention, demand, play, and tangible). Sessions for each condition lasted 10 min, and one cycle of conditions was conducted daily. The conditions

were chosen after observing Rafiki in her environment before the experiment began. It was decided that each of these conditions could have been associated with a reinforcement contingency that maintained SIB. During all conditions of the functional analysis, programmed consequences were delivered only for forms of SIB (i.e., no contingencies were arranged for lip smacking).

During the ignore condition, Rafiki was in her enclosure and did not have access to toys or enrichment items. The experimenter was in another room out of Rafiki's sight, and observers were in their assigned position (1 m away from Rafiki's enclosure). This condition was conducted to determine if Rafiki's SIB persisted in an austere environment in which no programmed social consequences were associated with SIB.

During the attention condition, Rafiki was in her enclosure and did not have access to toys or enrichment items. The experimenter sat on a crate next to the observers and talked to them while turning her back toward Rafiki. When SIB occurred, the observer would begin talking to Rafiki, which cued the experimenter that SIB occurred. At that point, the experimenter immediately turned toward Rafiki and delivered statements of concern or reprimands (e.g., "don't do that," "don't hurt yourself") until the SIB ended, which averaged 25 s for each bout (the observer stopped delivering attention when the experimenter began delivering attention). This condition was conducted to determine whether SIB was maintained by positive reinforcement in the form of contingent social attention.

Prior to sessions in the tangible condition, Rafiki was given a ball on a chain to play with for 30 s. The session began when the experimenter pulled the chain through the fence to remove the ball at the end of 30 s (regardless of whether Rafiki was playing with it). Then, contingent on the occurrence of the SIB, the experimenter presented the ball to Rafiki. After

30 s elapsed without SIB, the experimenter pulled the chain to take up the ball and waited for the next occurrence of SIB. This condition was conducted to determine if the contingent delivery of play objects functioned as positive reinforcement for Rafiki's SIB.

During the demand condition, the experimenter gave the command "house." *Compliance* was defined as Rafiki entering her wooden den box and remaining there for 10 s. If Rafiki complied with the command, the experimenter said "okay" (this was a previously trained signal that Rafiki could leave her house, approach the experimenter, and receive two raisins for complying with the instruction). The command "house" was repeated 30 s after she left the house. If Rafiki emitted SIB, the experimenter moved about 1.5 m away from the cage with her back turned for 5 s and then repeated the command. If Rafiki did not comply or emitted any other behavior within 5 s of the demand, the demand was repeated every 5 s until she complied or until SIB occurred (upon which the experimenter provided a break). Because this behavior was needed for the animal's daily husbandry, we implemented a relatively brief (5 s) escape interval so that the behavior would not be extinguished. The number of demands varied from session to session depending on Rafiki's behavior, but the experimenter delivered a mean of 16 demands per session. The demand condition was conducted to determine if escape from demands functioned as negative reinforcement for Rafiki's SIB.

Finally, a play condition was conducted in which a ball on a chain was placed into the cage. The experimenter set a resetting timer for 30 s. If, after 30 s, Rafiki was interacting with the ball, the ball remained there. However, if Rafiki was not interacting with the ball, the experimenter reintroduced the ball by pushing it toward Rafiki with an iron rod. If Rafiki emitted SIB as the experimenter presented the ball, the experimenter stopped and waited until the behavior had not occurred for 5 s and then

re-presented the ball. This condition functioned as a control procedure, in which little SIB was expected to occur because Rafiki was receiving noncontingent social interaction and had access to alternative activities.

Treatment analysis. During this phase of the experiment, a baseline condition (identical to the attention condition described above) was contrasted with a treatment condition (differential reinforcement of alternative behavior [DRA] with extinction). During treatment, SIB no longer resulted in attention delivery; however, if Rafiki emitted the lip-smacking response, she received brief compliments (e.g., saying, "You look pretty today" or "Fantastic lip smacking"). The comments continued until lip smacking was completed. Lip smacking was chosen as an alternative behavior because the response was present in her repertoire at low frequencies, was considered to be an appropriate behavior, and was formally incompatible with some of the SIB (i.e., lip smacking and hand or foot biting could not occur simultaneously). All treatment sessions were 10 min in length, and the baseline and treatment conditions were compared in a reversal (ABAB) design.

RESULTS

Functional analysis. Figure 1 (top) depicts the occurrence of SIB across conditions during the functional analysis. The mean percentage duration of SIB was 23% in the attention condition, 2.5% in the ignore condition, and 0.3% in the play condition. SIB never occurred in the demand or tangible conditions. Thus, the results of the functional analysis suggest that SIB was maintained by positive reinforcement in the form of contingent attention delivery. Throughout the functional analysis, lip smacking (Figure 1, bottom) occurred at relatively low levels ($M_s = 3.2\%$ in attention, 2.6% in ignore, 2.2% in play, and 1.8% for both demand and tangible).

Treatment analysis. Figure 2 shows the duration of SIB and lip smacking during the

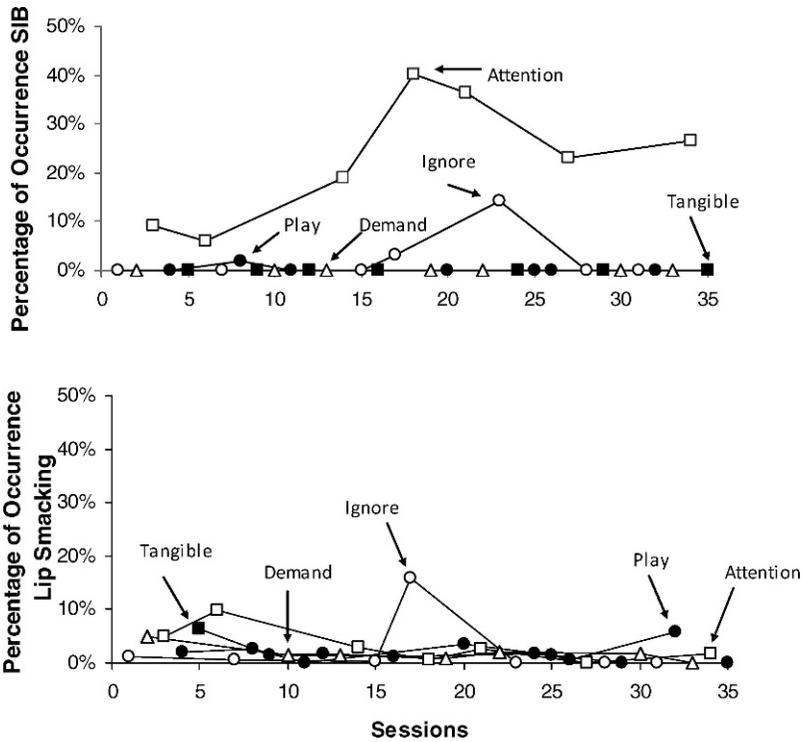


Figure 1. Percentage duration of SIB (top) and lip smacking (bottom) in the functional analysis.

baseline and treatment conditions of the treatment analysis. It should be noted that the data presented in the first phase of the treatment analysis were obtained during the attention condition of the functional analysis (Figure 1, top). During the initial baseline phase, both SIB and lip smacking initially occurred at moderate levels; however, SIB subsequently increased ($M = 23\%$) and lip smacking decreased ($M = 3.2\%$). When lip smacking was differentially reinforced with attention delivery and SIB was placed on extinction, neither response occurred initially. However, once lip smacking and SIB contacted the respective contingencies, lip smacking gradually increased and was maintained at high levels throughout the remainder of the condition ($M = 20\%$). By contrast, levels of SIB remained low throughout this phase ($M = 1.2\%$). The duration of SIB increased ($M = 19\%$) during the reversal to baseline, whereas lip smacking decreased ($M = 4\%$). Finally, when the treatment was reimplemented, SIB

decreased ($M = 0.3\%$) and relatively high levels of lip smacking emerged ($M = 18\%$).

DISCUSSION

The results of the functional analysis suggested that Rafiki's SIB was influenced by operant contingencies, specifically positive reinforcement (i.e., attention from humans). The results of the functional analysis were supported by the effects of providing attention contingent on SIB or lip smacking during the treatment analysis. That is, when SIB produced attention but lip smacking did not, SIB occurred at high levels and lip smacking occurred at low levels. Conversely, when lip smacking produced attention but SIB did not, lip smacking occurred at high levels and SIB occurred at low levels.

Current paradigms for the study of problem behavior in captive animals focus their analysis on three general areas outlined by Mills (2003,

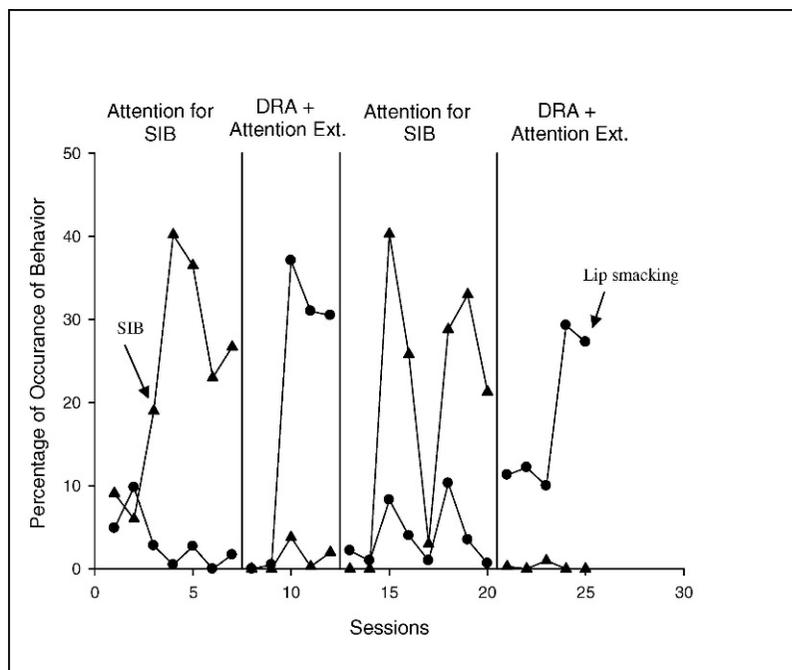


Figure 2. Percentage duration of lip smacking and SIB during the treatment analysis.

p. 279): (a) behaviors that have adaptive value within the species but that are inconvenient for the keeper (adaptive behaviors such as fear responses); (b) attempts to behave in an adaptive way in an environment to which complete adaptation is not possible (maladaptive behaviors such as trying to escape from an environment where an escape is not possible); and (c) expressions of direct disruptions of the nervous system (malfunctional behaviors such as stereotypy). The notion that problem behaviors displayed by captive animals are related to ecological adaptations suggests that an appropriate course of treatment would be to alter the environment to accommodate behaviors that had functional value in the evolution of the species (e.g., enrichment).

With respect to ecological manipulations, Watson (1992) found that the addition of a foraging apparatus decreased the frequency of self-biting in 2 rhesus macaques. However, it is not clear when and what modifications to the environment will be effective (Watson, Cosby, & Lee-Parritz, 1993), and some studies have

reported persistence of SIB even when animals use enrichment items as intended (Kinsey, Jorgensen, & Novak, 1997; Kinsey, Jorgensen, Platt, & Hazen, 1996). Furthermore, inclusion of enrichment items may be detrimental in some cases if keepers provide access to the enrichment items as a consequence for problem behaviors to stop the behaviors, thereby inadvertently reinforcing the behavior. Thus, although the analysis of the effects of ecological manipulations on SIB in primates is promising, additional research is needed to increase our understanding of these manipulations and their use in the treatment of SIB. As evidenced in the current investigation, operant approaches can also affect the occurrence of SIB in primates.

The current results suggest that SIB was modifiable through the use of operant contingencies. Of course, that Rafiki's SIB was maintained by the attention of humans does not explain the etiology of this behavior in the present case. It is possible that Rafiki's SIB initially emerged due to exposure to a variety of ecological variables (e.g., her prolonged indi-

vidual housing or separation from a sexual partner). Such variables have been associated with the occurrence of SIB in primates (Chamove *et al.*, 1984; Erwin *et al.*, 1973; Redican & Mitchell, 1973; Reinhardt & Rossell, 2001). Thereafter, it is possible that SIB became an operant response in that this behavior produced a consistent and reinforcing consequence from caregivers (*i.e.*, attention). This explanation is speculative, and additional research should address variables that lead to the emergence of SIB in nonhuman animals.

The present research adds to previous literature in that it identifies roles and aspects of the environment that can be relevant to SIB but had not been investigated previously. In particular, it highlights the role of keepers and other humans as part of the ecology of captive animals; shows that the SIB can be operant behavior maintained by reinforcing consequences in that environment; and presented a nonintrusive, consequence-based intervention that effectively reduced SIB by differentially attending to a more desirable behavior.

The current research also supports the utility of the functional analysis method developed by Iwata *et al.* (1982/1994). As noted before, functional analysis has been shown to be effective at identifying the maintaining reinforcement contingencies for problem behavior in several types of human populations (Hanley, Iwata, & McCord, 2003). The current investigation represents the first extension of this particular method to nonhuman populations. It is important to note, however, that the use of functional analyses to assess the function of problem behavior in captive animals can be cumbersome due to the subtle, idiosyncratic, and sometimes paradoxical events that may function as reinforcement for a given animal. A reinforcer may range from a type of food to a pat on the back. Furthermore, some animals may be sensitive to forms of reinforcement that would act as punishment for other animals, such as a squirt of water to the face. Thus it may

often be necessary to tailor functional analysis procedures to individual animals. In such cases, potential reinforcers should be identified through descriptive observation, and functional analysis procedures should be developed that test whether these consequences function as reinforcement for the problem behavior under study. Nevertheless, the current results support the utility and flexibility of analogue functional analyses.

After the maintaining reinforcer for problem behavior was identified via the functional analysis, the results of the analysis were validated by implementing a treatment program that corresponded to the hypothesized maintaining contingency (Northup *et al.*, 1991). The current investigation involved differential reinforcement of a response that already existed in the animal's repertoire. Similar approaches have been used to identify appropriate alternatives to problem behavior in human populations. For example, Grow, Kelley, Roane, and Shillingsburg (2008) collected baseline data on several potential appropriate behaviors for 3 individuals with developmental disabilities. When problem behavior was placed on extinction, an alternative and more socially appropriate topography of behavior emerged in all cases. Similarly, in the current investigation, data were collected on lip smacking, grunts, and alarms called during the functional analysis. The relative frequency of lip smacking suggested this response as an alternative to SIB. Thus, during treatment, this preexisting response was differentially reinforced as a form of treatment for SIB.

In summary, the current study is the first to demonstrate the utility of functional analysis in the assessment and treatment of problem behavior in a nonhuman animal (*i.e.*, an olive baboon). Functional analysis may offer considerable promise in assessment and treatment of SIB in captive animals and pets. Future research should be conducted involving additional participants, different species, different environments, and other behaviors (*e.g.*, self-stimula-

tion and aggression) to determine the general utility of functional analyses for the assessment and treatment of behavior disorders in nonhuman animals.

REFERENCES

- Baker, K., Banjanin, S., Barley, J. B., Bell, L., Davis, E., Garner, J. P., et al. (2004). Self-injurious biting in laboratory animals: A discussion. *Laboratory Primate Newsletter*, 43, 11–12.
- Bellanca, R. U., & Crockett, C. M. (2002). Factors predicting increased incidence of abnormal behavior in male pigtailed macaques. *American Journal of Primatology*, 58, 57–69.
- Bloomsmith, M. A., Marr, M. J., & Maple, T. L. (2007). Addressing nonhuman primate behavioral problems through the application of operant conditioning: Is the human treatment approach a useful model? *Applied Animal Behaviour Science*, 102, 205–222.
- Carlstead, K. (1998). Determining the causes of stereotypic behaviours in zoo carnivores. In D. Shepherdson, J. Mellen & M. Hutchins (Eds.), *Second nature* (pp. 172–183). Washington, DC: Smithsonian Press.
- Chamove, A. S., Anderson, J. R., & Nash, V. J. (1984). Social and environmental influences on self-aggression in monkeys. *Primates*, 25, 319–325.
- Eaton, G. G., Worlein, J. M., Kelley, S. T., Vijayaraghavan, S., Hess, D. L., Axthelm, M. K., et al. (1999). Self-injurious behavior is decreased by cyproterone acetate in adult male rhesus (*Macaca mulatta*). *Hormones and Behavior*, 35, 195–203.
- Erwin, J., Mitchell, G., & Maple, T. (1973). Abnormal behavior in non-isolate-reared rhesus monkeys. *Psychological Reports*, 33, 515–523.
- Grow, L. L., Kelley, M. E., Roane, H. S., & Shillingsburg, M. A. (2008). Utility of extinction-induced response variability for the selection of mands. *Journal of Applied Behavior Analysis*, 41, 15–24.
- Hanley, G. P., Iwata, B. A., & McCord, B. E. (2003). Functional analysis of problem behavior: A review. *Journal of Applied Behavior Analysis*, 36, 147–185.
- Hosey, G. R., & Skyner, L. J. (2007). Self injurious behavior in primates. *International Journal of Primatology*, 28, 1431–1437.
- 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., 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.
- Kinsey, J. H., Jorgensen, M. J., & Novak, M. A. (1997). The effects of grooming boards on abnormal behavior in rhesus monkeys (*Macaca mulatta*). *American Journal of Primatology*, 42, 122–123.
- Kinsey, J. H., Jorgensen, M. J., Platt, D. M., & Hazen, T. J. (1996). Food puzzle feeders: Effects on self-biting and stereotypy in individually housed monkeys [Abstract]. *International Primatological Society/Conference of the American Society of Primatologists Congress Abstracts*, 16, 683.
- Layng, J., Andronis, P., & Goldiamond, I. (1999). Animal models of psychopathology: The establishment, maintenance, attenuation, and persistence of head-banging by pigeons. *Journal of Behavior Therapy and Experimental Psychiatry*, 30, 45–61.
- Lovaas, I. O., & Simmons, J. Q. (1969). Manipulation of self-destruction in three retarded children. *Journal of Applied Behavior Analysis*, 2, 143–157.
- Lutz, C., Well, A., & Novak, M. (2003). Stereotypic and self-injurious behavior in rhesus macaques: A survey and retrospective analysis of environment and early experience. *American Journal of Primatology*, 60, 1–15.
- Macy, J. D., Jr., Beattie, T. A., Morganstern, S. E., & Arnstern, A. F. (2000). Use of guanfacine to control self-injurious behavior in two rhesus macaques (*Macaca mulatta*) and one baboon (*Papio anubis*). *Comparative Medicine*, 50, 419–425.
- Mills, D. S. (2003). Medical paradigms for the study of problem behavior: A critical review. *Applied Animal Behaviour Science*, 81, 265–277.
- Morgan, K. N., Line, S. W., & Markowitz, H. (1998). Zoos, enrichment, and the skeptical observer. In D. Shepherdson, J. Mellen, & M. Hutchins (Eds.), *Second nature* (pp. 153–171). Washington, DC: Smithsonian Press.
- National Research Council. (1998). *The psychological well-being of nonhuman primates*. Washington, DC: National Academy Press.
- Northup, J., Wacker, D., Sasso, G., Steege, M., Cigrand, K., Cook, J., et al. (1991). A brief functional analysis of aggressive and alternative behavior in an outclinic setting. *Journal of Applied Behavior Analysis*, 24, 509–522.
- Novak, M. A. (2001). Primate psychopathology: New insights on etiology and physiology [Abstract]. *American Journal of Primatology*, 54(S1), 111.
- Novak, M. A., Kinsey, J. H., Jorgensen, M. J., & Hazen, T. J. (1998). Effects of puzzle feeders on pathological behavior in individually housed rhesus monkeys. *American Journal of Primatology*, 46, 213–227.
- Redican, W. K., & Mitchell, G. (1973). The social behavior of adult male-infant pairs of rhesus macaques in a laboratory environment. *American Journal of Physical Anthropology*, 38, 523–526.
- Reinhardt, V., & Rossell, M. (2001). Self-biting in caged macaques: Cause, effect, and treatment. *Journal of Applied Animal Welfare Science*, 4, 285–294.

- Sailor, W., Guess, D., Rutherford, G., & Baer, D. M. (1968). Control of tantrum behavior by operant techniques during experimental verbal training. *Journal of Applied Behavior Analysis, 1*, 237–243.
- Schaefer, H. H. (1970). Self-injurious behavior: Shaping “head-banging” in monkeys. *Journal of Applied Behavior Analysis, 3*, 111–116.
- Tiefenbacher, S., Novak, M. A., Jorgensen, M. J., & Meyer, J. S. (2000). Physiological correlates of self-injurious behavior in captive, socially-reared rhesus monkeys. *Journal of Psychoneurology, 25*, 799–817.
- Tinklepaugh, O. L. (1928). The self-mutilation of a male *Macacus rhesus* monkey. *Journal of Mammalogy, 9*, 293–300.
- Watson, L. (1992). Effect of an enrichment device on stereotypic and self-aggressive behaviors in singly-caged macaques: A pilot study. *Laboratory Primate Newsletter, 31*, 8–10.
- Watson, L., Cosby, R., & Lee-Parritz, D. E. (1993). Behavioral effects of enrichment devices on laboratory primates with stereotypic and self-directed behavior. *American Journal of Primatology, 31*, 355–356.

Received February 2, 2007

Final acceptance February 13, 2009

Action Editor, Henry Roane