Combination Therapy Reduces Self-injurious Behavior in a Chimpanzee (Pan Troglodytes Troglodytes): A Case Report

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Self-injurious behavior (SIB) remains a severe and intractable abnormal behavior for nonhuman primates in diverse settings and is a significant concern for veterinarians and behavioral scientists. To date, no single pharmacological, behavioral, social, or environmental intervention method has emerged as a reliable permanent cure for treating SIB in all, or even most, individuals. Implementation and evaluation of a combination therapeutic approach to treating SIB for nonhuman primates is rare. In May 2004, a 25-year-old male chimpanzee with severe SIB ($M = 2.09$ episodes/day, range $= 1–4$ episodes/day) underwent intensive behavioral intervention that utilized a combination of techniques. The combination therapy approach entailed the following: (a) pharmacological intervention with a gamma-aminobutyric acid (GABA) analogue to treat suspected HIV-related sensory neuropathic pain, (b) positive reinforcement training, and (c) environmental enrichment, as well as social and environmental modification. The severity of SIB warranted immediate implementation of intensive combination therapy rather than a systematic evaluation of the individual treatment options. The individually tailored, multifaceted combination therapy resulted in the virtual elimination of SIB in this chimpanzee over a 2-year period.

A small percentage of captive nonhuman primates are known to develop behaviors directed toward their own bodies in the form of hitting, biting, or banging.
one’s self against the cage (Anderson & Chamove, 1985; Lutz, Well, & Novak, 2003; Novak, 2003). This self-aggressive behavior can become so severe as to lead to self-injury in the form of massive tissue and muscle damage, severe laceration, or dismemberment, necessitating veterinary treatment, amputation, and—on occasion—euthanasia (Anderson & Chamove, 1980; Bushong, Shapiro, & Bloomsmith, 1992; Capitanio, 1986). Self-aggression (self-directed violence without wounding) and self-injurious behavior (SIB) resulting in tissue damage are the most severe abnormal behaviors observable in captive primate colonies and the most resistant to standard treatment approaches (Kinsey, Jorgensen, & Novak, 1997; Novak, Kinsey, Jorgensen, & Hazen, 1998). Self-aggression and subsequent self-injury have a tendency to be elicited by diverse stressors, and the exact causal factor for the disturbance is not always obvious (Novak et al., 1998). Chronic stressors (prolonged single housing, recurrent blood draws, or other potentially invasive procedures) combined with variables such as sex and rearing history have been posited as likely contributing factors to the development and maintenance of SIB in rhesus macaques (Lutz et al., 2003; Novak et al., 1988).

Although stress seems to have a strong influence in the emergence and maintenance of SIB and has been widely researched, less attention has been directed to underlying organic or clinical factors that may contribute to the etiology of SIB (James-Aldridge, 2005). It is well documented that nonverbal humans with and without diverse developmental disabilities have developed SIB (head or body banging, self-hitting, self-scratching, self-biting); when further examined, they revealed painful underlying clinical conditions, such as otitis media, impacted bowel, menstrual pain, and dermatitis (Carr & McDowell, 1980; de Lissovoy, 1963; MacLean & Symons, 2002; Symons, 2002). Research in humans has shown that SIB can sometimes develop as a response to painful clinical conditions and be subsequently reinforced and maintained through social attention or other environmental variables and ultimately generalize to a wide range of situations (Carr, 1977; Carr & McDowell, 1980). Humans afflicted with SIB of an initial organic etiology (ear infections) have been successfully treated through a combination of intervention methods (Symons & Thompson, 1997). Pharmacological treatment can address underlying clinical conditions, whereas behavior modification techniques combat the social and environmental reinforcers that maintain the behavior (Carr & McDowell, 1980; Smolev, 1971). A preexisting clinical condition that has gone unchecked due to the nonverbal nature of the afflicted individual complicates treatment and makes a monotherapeutic approach less likely to be effective because it may only target one facet of a multifaceted disorder. Symons and Thompson (1997) noted: “Indeed, there are certain patterns of problem behavior where the biological and social mechanisms are so inextricably intertwined that rarely can a single approach to treatment fully improve the situation” (p. 69). Although the presence of painful clinical conditions has not been widely researched in SIB nonhuman primates, it is possible that
these individuals might be successfully treated using a combination therapy approach similar to those employed in human populations.

Some studies have evaluated the effectiveness of monotherapy approaches to self-aggression and SIB in nonhuman primate species, rather than any potential combined efficacy. A variety of psychotropic and pharmacologic medications have been used to treat SIB, with varying success (Eaton et al., 1999; Izard & Langner, 2004; Macy, Beattie, Morgenstern, & Arnsten, 2000; Pond & Rush, 1983; Ribka & Baker, 2004; Wallace, Bell, Prosen, & Clyde, 1998; Weld et al., 1998). Choosing a suitable and effective pharmacologic agent for SIB treatment can be difficult, especially for individuals with compromised immune systems or impaired organ function. Furthermore, pharmacologic agents with sedative qualities may preclude social housing. Positive reinforcement training (PRT) techniques and human interaction have been shown ineffective in reducing SIB in rhesus macaques (Baker, Bloomsmit, Griffis, & Gierhart, 2003).

Among those treating anxiety and stress-related disorders in humans, there is ongoing debate as to the efficacy of monotherapies (cognitive, behavioral, or pharmacological) versus combination therapies (Foa, Franklin, & Moser, 2002; Hohagen et al., 1998; Lader & Bond, 1998; Otto, Smits, & Reese, 2005; van Balkom et al., 1998). Randomized, placebo-controlled studies substantiate a therapeutic advantage of behavioral therapy, with or without combined pharmacological treatment, over medication alone (Cottraux, Mollard, Bouvard, & Marks, 1993; Foa, Kozak, Steketee, & McCarthy, 1992; Foa et al., 2005; Lindsay, Gamsu, McLaughin, & Hood, 1987). Lader and Bond observed that “various treatments can act synergistically on different aspects of [a] disorder. … Behavior therapy may be used to modify the maladaptive behavior” (p. 43), whereas medication can treat underlying, motivating physiological mechanisms or clinical conditions.

Counterconditioning, incompatible behavior training (behaviors that are difficult or impossible to perform at the same time as the target undesirable behavior), other training techniques (Pryor, 1999; Ramirez, 1999; Tarpy & Bourne, 1982), human-based exposure therapy (Barlow, 2002), and other “cognitive-behavioral techniques involve [individuals] actively learning to control their anxiety symptoms and to develop new adaptive coping mechanisms” (Power et al., 1990, p. 290; see also Tyron, 2005). Using a conditioned reinforcer (a metal clicker) to desensitize anxious animals to stimuli is a behavior modification technique that can facilitate the replacement of emotional and distress-related responses with more desirable, neutral behaviors (Parsons, 2004; Wright, Reid, & Rozier, 2005). The human field of applied behavior analysis also relies heavily on training incompatible behaviors, such as clasping hands to prevent hair pulling (de Luca & Holburn, 1984; Freeman, Horner, & Reichle, 2002; Miltenberger & Fuqua, 1985; Zhou, Goff, & Iwata, 2000). These behavior modification techniques, used in combination with pharmacological treatments, may also confer an advantage over monotherapy for nonhuman primates.
Although SIB has been intensively studied in human populations for several decades (Bachman, 1972; Carr, 1977; Kahng, Iwata, & Lewin, 2002), understanding and treating this destructive condition in nonhuman primates is just beginning. There are many behavioral modification techniques refined and used in human SIB treatment that may be directly applicable to afflicted nonhuman primates. To date, a multifaceted combination therapy approach to combating this disturbance has not been widely attempted for nonhuman primates (Prosen & Bell, 2000; Wallace et al., 1998).

This report describes the successful reduction of severe SIB in a chimpanzee (*Pan troglodytes troglodytes*), using a combination of behavioral intervention techniques similar to those employed in human populations. The severity of SIB exhibited by this individual warranted immediate implementation of intensive combination therapy rather than a systematic empirical evaluation of the individual treatment modalities (Kahng et al., 2002). The combination therapy approach described herein entailed pharmacological intervention, PRT, and individually tailored occupational enrichment, as well as social and environmental modification.

**METHODS AND MATERIALS**

**Subject and History**

In May 2004, Newt was a 25-year-old, 68.8-kg male, common chimpanzee housed at the Southwest National Primate Research Center (SNPRC), San Antonio, Texas. Newt was HIV viremic (blood samples consistently contained high levels of the HIV virus) with a history of hepatitis B exposure. Newt was mother reared for about 2 months at the Laboratory for Experimental Medicine and Surgery in Primates (LEMSIP), New York. He underwent nasal septum surgery at about 3 months of age. Newt was acquired by SNPRC in 1979, at about 4 months of age, and was subsequently nursery reared.

Newt had been housed with two adult females in an enclosure with indoor and outdoor access (22.4 m³ outside, 21.3 m³ inside) for 4 years when previously intermittent self-aggressive episodes resurfaced and became self-injurious in nature. Newt’s clinical records document minor self-injury in February 1987 and once again in September 1998, but these are the only reports prior to 2000. Newt was officially reported to the SNPRC Behavioral Intervention Program staff when he began exhibiting minor self-biting between March and June of 2003.

Newt had a known history of dental problems. In July 2003, his canines were extracted, as it was thought dental discomfort due to exposed nerves and cavities might be triggering his self-biting. To monitor his behavior more closely and to allow his self-inflicted wounds to heal, Newt was moved to indoor single housing. During this 2-month period, Newt maintained visual access with his former group.
Newt’s self-biting did diminish initially following canine extraction but resumed in the subsequent months. At this time, the SNPRC behavioral staff began a steady regimen of occupational enrichment and human interaction in an attempt to combat the SIB. In September 2003, Newt’s wounds had healed sufficiently, and he was reintroduced to his social group in their previous indoor–outdoor enclosure.

Between June 2003 and March 2004, Newt exhibited a consistent cycle of self-injury in which his behavior would peak with severe wounding and then subside. By April 2004, Newt’s SIB reached chronic and severe levels, and his quality of life was questionable. In addition, Newt would not use either of his hands for walking, climbing, eating, foraging, or other species-typical behaviors. No clinical explanation could be determined for his limited hand use, but HIV-related peripheral sensory neuropathic pain was suspected.

Video and live observations revealed a pattern of characteristic episodes of SIB. No single event or stimulus that triggered the behavior(s) could be determined, although specific behavioral cues indicated the onset of an episode. Prior to a SIB episode, Newt would “cry” excessively (defined as an individually distinctive, high-pitched vocalization), rub or poke at his posterior, and exhibit “floating limb” (see Erwin & Deni, 1979, p. 6), where his arm would appear to move on its own accord. Newt’s floating limb predominantly involved his right arm, which would flail about before he would ultimately attack and bite the hand and wrist of that arm. Newt would bite, scratch, and lacerate his fingers, toes, thighs, arms, legs, wrists, head, scrotum, and posterior, often necessitating clinical treatment. Newt’s self-aggressive and self-injurious episodes appeared to generalize to a wide range of stressors and aversive stimuli (restricting access to inside or outside areas during cage sanitation, veterinarian or technician presence in the area, and separation from favored staff). In addition to SIB, rocking and eye poking were also observed.

Social and Environmental Modification

Newt was moved from his previous group (indoor–outdoor enclosure with two adult females) to a low traffic, more structurally enriched, indoor–outdoor access enclosure (85.8 m³ outside, 23.9 m³ inside) with a familiar male companion, Buzz. At the time, Buzz was a 26-year-old, 71.5-kg male common chimpanzee, who had been housed with Newt 14 years prior for 7.5 years. Newt and Buzz were moved and reintroduced on March 12, 2004, 2 months before the initiation of the combination therapy. This social modification alone was not effective in diminishing the frequency or severity of Newt’s SIB.

In May 2004, SNPRC veterinary and behavioral staff agreed to try a combination therapeutic approach as a last attempt to moderate Newt’s severe SIB. The approach was three-tiered, involving pharmacological intervention, PRT, and
environmental enrichment. Newt’s indoor housing had two doors and window ports to an interior clinical procedure area. Newt would cry and appear distressed (exhibited rocking, eye poking, posterior rubbing) when he was able to view staff through these windows. Newt’s crying appeared to function to solicit human attention because his crying would immediately cease if or when people approached and interacted with him, and it resume as they left or began to leave. In response to these behaviors, Newt’s indoor windows were covered so he could no longer view staff working inside.

Video Observation and Data Collection

For the initial 2 weeks of treatment, a camcorder was placed in front of Newt’s outdoor enclosure to record activity from 08:00 to 17:00. Although the quality of these video recordings was not optimal, Newt’s SIB episodes were dramatic and easily identifiable on the video. Using an all-occurrences sampling method, videotapes were scanned to determine if a specific stimulus was eliciting Newt’s SIB. Anytime an episode occurred, the duration of the episode, the time of day, and potential causal factors were noted. These video observations alerted trainers that Buzz reacted aggressively to Newt’s episodes and often exacerbated the behavior. As a result, training was also initiated with Buzz to separate him from Newt should an episode occur and to reward Buzz for remaining calm.

Using videotapes with the best visibility, five 30-min continuous sampling focal observations were conducted using the Noldus Observer™ software. A total of 10 video observations captured Newt exhibiting SIB and allowed for quantification of these episodes. Video observations ceased after 2 weeks, as it proved too difficult to accurately assess behavior with this method due to limited visibility. Instead, staff relied on “SIB tracking sheets” that were posted outside Newt’s enclosure. The sheets allowed staff present during a crying or SIB episode to indicate the time of day, estimated duration (in minutes), and severity of the episode as mild (no injury or crying only), moderate (reinjury of existing wounds or superficial new injury), or severe (new laceration and/or many wounds). Staff also added comments and noted any possible causal or contributing factors.

Therapy Components

**Pharmacological treatment.** Peripheral sensory neuropathic pain is a clinical condition common in HIV-positive humans (Hahn et al., 2004). Distal symmetrical polyneuropathy (DSP) is the most common form of peripheral neuropathy associated with HIV infection (Verma, Estanislao, & Simpson, 2005). DSP is manifested predominantly as sensory symptoms such as neuropathic pain, which is
usually bilateral and described as numbness or burning. The pathogenesis is unknown but may involve viral-associated neurotoxicity and/or viral-triggered immune activation (Hahn et al., 2004; Schifitto et al., 2005). Anticonvulsants such as gabapentin have demonstrated efficacy in relieving pain associated with clinical conditions: diabetic peripheral neuropathy, postherpetic neuralgia, trigeminal neuralgia, and HIV-associated sensory neuropathies (Backonja & Serra, 2004; Dworkin et al., 2003; Gilron & Flatters, 2006; Hahn et al., 2004; Serpell & the Neuropathic Pain Study Group, 2002).

The mechanism by which gabapentin alleviates neuropathic pain has not been fully elucidated, but there is evidence it exerts an effect on the central nervous system by interacting with calcium channels; it also has been shown to inhibit discharge activity from injured nerves (Backonja & Serra, 2004; Hahn et al., 2004). Gabapentin has effectively reduced SIB in humans with clinical disorders such as Lesch-Nyhan syndrome (McManaman & Tam, 1999; Thompson & Caruso, 2002).

Gabapentin was selected for pharmacologic intervention for Newt for the following reasons:

1. It has analgesic properties in alleviating sensory neuropathic pain (suspected because of HIV status and limited hand-use),
2. It has minimal adverse effects on organ function (compromised liver function due to coinfection with hepatitis B virus);
3. There is an absence of sedative effect, and
4. It has a low drug interaction profile. Gabapentin is not appreciably metabolized in humans and is eliminated by the kidneys, and it may have additional mood enhancing and anxiolytic properties, which may further help reduce distress and anxiety and promote recovery in individuals exhibiting SIB (Pande et al., 2000).

In mid-June 2004, gabapentin (Neurontin®, Pfizer Co., New York) was prescribed after Newt began to exhibit behavioral improvement from 2 weeks of PRT and increased environmental enrichment. The medication was mixed with Tang™ and administered orally by husbandry staff. The initial dose was titrated to 300 mg of gabapentin three times a day (based on dose recommendation to treat postherpetic neuralgia; Physicians’ Desk Reference, 2005). From August 2 to August 9, 2004, Newt’s dose was decreased to 300 mg twice a day, but it was increased back to three times a day one week later when he began to show signs of regression e.g., increased crying and rocking.

Positive reinforcement training. Due to ethical constraints and the severity of Newt’s SIB, we could not conduct a full empirical assessment (functional assessment) or intervention method that directly modeled those of the field of human
behavior modification (Cooper, 1987). Nevertheless, Newt’s behavioral interventions were based largely on many of the techniques found to be effective in the treatment of SIB in humans (Barlow, 2002; Carr & McDowell, 1980; Cooper, 1987; de Luca & Holburn, 1984; Freeman et al., 2002; Martin & Pear, 1999; Miltenberger & Fuqua, 1985; Smolev, 1971; Wacker, Northup, & Lambert, 2001; Zhou et al., 2000). Specifically, the behavior modification methods utilized included the following:

1. Structured relaxation training (rewarding remaining in a calm, alert, focused, and seated position without exhibiting piloerection, displaying, rocking, or other behaviors indicative of arousal),
2. Desensitization (a process designed to overcome fear by pairing rewards with any action or object that causes arousal),
3. Incompatible behavior training, and
4. Differential reinforcement of alternative behavior (rewarding all affiliative conspecific interactions as they occur, and ignoring less desirable responses) (Ramirez, 1999).

Until November 2004, all training sessions took place with one primary trainer for each chimpanzee. Buzz was trained to separate from Newt to an adjacent enclosure and remain at a specific target location in a calm and seated position to discourage him from aggressing toward Newt should an episode occur. To increase the frequency of desirable social interactions, all affiliative interactions between Newt and Buzz were reinforced when they occurred, even if both individuals left their trainers to touch each other through caging (differential reinforcement of alternative behavior).

The primary objective for Newt’s training was to greatly reduce or eliminate his SIB by desensitizing him to external stressors and teaching him more appropriate coping behaviors. Newt was trained to perform an incompatible behavior that entailed sitting in the front of his cage with his feet on the floor and hands on the cage mesh. From this position, he was gradually desensitized (using a metal clicker as a conditioned reinforcer and a food or juice reward) to closing guillotine doors, separation from his cage mate, the presence of veterinary technicians and their vehicle, strangers, and other aversive stimuli. Newt was also trained to relax on command by being rewarded for remaining calm when favored personnel left him, as separation was particularly difficult for him to tolerate. The crucial part of Newt’s desensitization was teaching him to remain calm and positioned with his hands on the cage and to not exhibit floating limb, injure himself, or otherwise act self-destructively when confronted with environmental stressors.

It was determined early on in the training process that Newt and Buzz’s trainers and caregivers would not approach Newt if he was crying or exhibiting SIB due to the risk of reinforcing these undesirable behaviors with attention. A clear verbal
and visual signal was given at the end of each training session. At that time, the trainers provided enrichment to Newt and immediately left the area. If Newt cried or self-aggressed when trainers were leaving, they did not return so as not to reinforce this behavior with additional attention. Newt’s trainer intervened during a SIB episode only if it occurred during the session since Newt was already receiving attention. At that time, Newt was called by his trainer to the cage front and asked to “target” with his hands on the cage and to “focus,” a command used to get Newt to pay attention to his trainer. Newt was also taught the command, “steady,” to combat his rocking and to reinforce a relaxed, calm, alert, and seated position.

Should an episode occur during a session, the session was not ended until Newt was calm and performed at least one more behavior (touching a target) to ensure that these episodes could not be used to terminate “work” and initiate potentially less taxing human interaction, such as grooming.

After 6 months and consistent improvement, Newt’s training shifted focus to more basic husbandry behaviors, such as presenting body parts for inspection and voluntarily presenting for injection and sedation to minimize stress. Newt’s intervention behaviors (stationing, targeting) were consistently maintained should regression occur and his SIB resurface. Newt was also trained to present all body parts previously injured, to hold position, and to tolerate antibiotic ointment application to expedite healing should he injure himself again. Newt was trained to come up to, go to, or remain stationed at specific targets or locations to increase overall activity, gross motor skills, exercise, and use of his enclosure. Although these behaviors did not directly address his SIB, it was hoped that the training process itself would engender more agency, control, and predictability and thus have a generalized therapeutic effect.

Environmental enrichment. Environmental enrichment is the provision of a variety of structures, items, choices, experiences, and procedures to captive animals that elicit or invite species-appropriate behaviors (Young, 2003). During the summer of 2003, Newt was recovering from self-inflicted wounds and dental surgery and was placed on an intensive enrichment schedule that included daily use of feeding devices, manipulable objects, sensory enrichment, and human interaction. During this time, the effectiveness of specific enrichment items for this individual was evaluated.

During the combination therapy approach, all items that Newt previously expressed no interest in, those that were marginally used, or those that elicited an adverse response (rocking, crying, or SIB) were eliminated. Food-related enrichment devices and human interaction were found to be the most effective in sustaining interest and maximizing the time spent engaged in constructive species-appropriate behaviors. The enrichment items were also selected to combat some of his behavioral deficiencies. These items functioned to increase hand use and improve
sensorimotor skills, manual dexterity, and cage exploration. In addition, they encouraged object manipulation and other species-appropriate behaviors such as foraging, food extraction, brachiating, climbing, and suspensory feeding. Encouraging object manipulation also offered another incompatible behavior that made Newt’s SIB difficult or impossible to perform while using the enrichment. Newt’s short attention span and minimal hand use limited the enrichment that could be implemented. Items utilized had to have a high visibility of potential reward and had to contain highly desirable items that were not too challenging or frustrating to extract. Human interactions entailed grooming exercises that helped improve fine motor skills by encouraging the use of hands and fingers.

In addition to using environmental enrichment to elicit more species-appropriate behaviors, feeding devices, such as banana feeders, foraging boards, and challenger balls (all trademarked items from Bio-Serv, Frenchtown, New Jersey) were offered at the end of each training session in order to pair a desirable item (food) with a stressful event (social separation). To maintain consistency, all husbandry staff used a similar approach (offering a piece of fruit) before they left Newt’s area. This routine added stability, structure, and predictability to Newt’s environment.

Specific sensory enrichment assisted Newt during times when people were not present. During instances when Newt and Buzz were restricted to the inside portion of the enclosure, they were shown children and infant videotapes (Baby Einstein, Sesame Street) because these media were geared for individuals with short attention spans and provided constantly changing multisensory scenes. These videos were also used during the early afternoon, which was determined by observation to be the time Newt was prone to exhibit SIB episodes.

RESULTS

Self-injurious Behavior

Data compiled from video observation and SIB tracking sheets confirmed frequent bouts of SIB (\(M = 2.09\) episodes/day, range = 1–4 episodes/day; see Table 1), with severe SIB resulting in tissue damage (33% of episodes) necessitating clinical treatment. After therapy was initiated, Newt’s SIB episodes decreased in their duration (pretherapy, \(M = 5.6\) min; November–December 2004, \(M = 2.0\) min), frequency (pretherapy, \(M = 63.7\) episodes/month; November–December 2004, \(M = 8.5\) episodes/month), and severity (pretherapy, 33% episodes moderate or severe with wounding; November–December 2004, 100% episodes mild with no wounding). The total number of Newt’s crying bouts decreased after permanently covering his indoor windows in November 2004. Since his therapy, Newt has consistently used his hands in a species-typical fashion for
<table>
<thead>
<tr>
<th></th>
<th>Pretherapy</th>
<th>Therapy</th>
<th>Maintenance</th>
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<tr>
<td>Total no. of episodes</td>
<td>48</td>
<td>24</td>
<td>26</td>
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<tr>
<td>No. of severe SIB</td>
<td>11</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>No. of moderate SIB</td>
<td>5</td>
<td>5</td>
<td>6</td>
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<tr>
<td>No. of mild SIB (crying only)</td>
<td>32</td>
<td>18</td>
<td>20</td>
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<tr>
<td>% of mild episodes (crying only)</td>
<td>67%</td>
<td>75%</td>
<td>77%</td>
</tr>
<tr>
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<td>3.72 min</td>
<td>2.48 min</td>
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<td>Mean frequency of episode</td>
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<td>12/month</td>
<td>13/month</td>
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<tr>
<td>No. of SIB-related sedations</td>
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<td>0</td>
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<tr>
<td>Estimated clinical cost (sedation, medication, labor)</td>
<td>$2.15/dayc</td>
<td>$5.04/dayd</td>
<td>$5.04/dayd</td>
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**Note.** SIB = self-injurious behavior. SIB episodes were defined as severe (i.e., new laceration and/or many wounds), moderate (i.e., reinjury of existing wounds or superficial new injury), or mild (i.e., no injury or crying only).

*SIB tracking sheets were implemented February 2004; thus, data reflect only those episodes documented from February through April 2004; mean frequency for pretherapy determined by total number of episodes divided by total number of days.*

*Because of the unexpected loss of Newt’s caregiver, 10 episodes the actual frequency for his SIB, for the month of December 2006; however, only 2 episodes outside of that month.*

*Estimated daily clinical cost of pretherapy SIB management determined by total cost ($783.35) divided by 365 days.*

*The cost of administering gabapentin three times daily.*
object manipulation, feeding, and locomotion and shows no restriction in his hand use. Newt’s rocking and eye-poking have been observed only during times of acute stress, particularly when restricted to the inside area or when responding to unpredictable environmental changes (new animals in the building, weekly husbandry staff rotation, and increased veterinary technician presence). Superficial injuries (small scrapes or cuts) were documented; however no self-biting occurred through November 2006.

In December 2006, Newt’s primary caregiver resigned unexpectedly, and Newt exhibited mild self-biting and anxiety-related behaviors during the transition to his new care provider (approximately 2 weeks). In response, intensive training was initiated for all husbandry personnel designated to work in Newt’s area. All caregivers were trained on incorporating PRT into their daily routines and on interacting with Newt. In addition, they were trained on implementing techniques—time-outs and rewards—to shape appropriate behavior and discourage more destructive responses, such as SIB. Since January 2007, Newt’s behavior has stabilized. Newt has adjusted to his new caregivers; no self-biting has been observed.

Time Investment and Expenses

Newt’s therapy commenced with 20-min PRT sessions scheduled twice a day, 5 days a week for 2 weeks, which then decreased in 2-week intervals as Newt’s behavior began to improve (frequency of severe SIB episodes decreased). In addition to regular daily enrichment that all SNPRC chimpanzees receive, Newt was offered supplemental enrichment. These enrichment items were offered twice daily ($M$ time investment = 128 min/week) from May 19–June 4, 2004, and the frequency of providing these devices decreased as his behavior stabilized. In 2-week increments, enrichment was decreased so that Newt was provided with supplemental enrichment once daily for 2 weeks, 3 times a week for 2 weeks, twice a week for 2 weeks, and ultimately once per week. By December 1, 2004, Newt’s SIB had subsided, and it was feasible to transfer all training and enrichment responsibilities to a single person. Since then, the time investment has been about 40 min per week: training once per week for 25 min, and feeding devices once per week for 15 min (Figure 1).

From July 2003 to May 2004, Newt required eight sedations as a result of SIB (two surgeries and six wound treatments), with an estimated cost of $478.08 (including sedation, blood draws, and labor costs), as well as 15 to 20 cage-side visits by a veterinarian. The estimated cost of Newt’s pain management and antibiotic medications in the year prior to Newt’s therapy was $305.27, for a combined total of $783.35 in clinical expenditures. The current cost of administering 300 mg of Neurontin® (gabapentin) 3 times a day is $5.04 per day.
DISCUSSION

The individually tailored, multifaceted combination therapy resulted in the successful reduction and virtual elimination of severe SIB in this chimpanzee. Newt has not wounded himself, necessitating clinical intervention, since the initiation of the combination therapy on May 19, 2004. Furthermore, he has shown improvement in every arena in which he was previously deficient: fine and gross motor skills (increased hand use), social navigation, and coping skills. Although the possibility and importance of a concomitant clinical and environmental basis for SIB should not be ignored, the presence of HIV-related sensory neuropathic pain offers a plausible explanation for the development of SIB in this chimpanzee. If Newt’s restricted hand use was related to suspected peripheral sensory neuropathic pain, gabapentin has been shown to be an extremely effective first-line treatment in alleviating this painful condition (Dworkin et al., 2003; Serpell & the Neuropathic Pain Study Group, 2002), and may explain why his overall hand use improved throughout treatment. Nevertheless, consistently encouraging grooming exercises and interaction with devices that required hand use likely also contributed to improvement in his fine motor skills and manual dexterity. Today, Newt continues to appropriately use his hands in social interactions, locomotion, and feeding.
Prior to this intensive intervention, Newt exhibited poor social skills and tended to ignore Buzz. Since initiating the combination therapy and differentially reinforcing all affiliative social interactions between the chimpanzees, Newt has learned to exhibit reciprocal social behavior (offering reassurance when Buzz is aroused or agitated). Research has shown that PRT can be an effective tool in modifying conspecific affiliative and aggressive interactions in primate species (Bloomsmith, 1994; Schapiro, Perlman, & Boudreau, 2001). Newt now regularly initiates reciprocal play, grooming, reassurance, and other species-appropriate affiliative behaviors with Buzz.

In the weeks after his therapy began, Newt was observed (via videocamera) on three occasions crying and placing his floating limb behind a guillotine door, out of his sight, and subsequently stationing with his free hand and calming down (his behavior did not escalate to SIB). This is similar to reports in the human literature of individuals with SIB placing themselves into positions that are incompatible with self-injury (Fovel, Lash, Barron, & Roberts, 1989; Powell, Bodfish, Parker, Crawford, & Lewis, 1996; Schroeder & Luiselli, 1992). Prior to the intervention, Newt would attack, and often injure, this arm while in this highly aroused state. Through a combination of gabapentin, PRT, and enrichment, it appears that Newt learned to control his arousal without human assistance and alter the trajectory of this behavior to avoid self-injury.

Many adjustments were made to the components of Newt’s combination therapy, particularly altering the type and schedule of enrichment devices, modifying training times, session types, and techniques utilized, as well as once adjusting the dosage of gabapentin. Given the overall success of combination therapy for Newt, it may be that the behavioral, environmental, pharmacological, and social aspects of the therapy worked in conjunction to ameliorate multiple reinforcing and motivating aspects of SIB. In contrast, individual monotherapies have been less effective in addressing SIB (Baker et al., 2003; Novak et al., 1998). The notion of multiple motivating and reinforcing factors for SIB necessitating a combination of intervention methods has been substantiated by more than three decades of rigorous empirical SIB research in human populations (Carr, 1977; Carr & McDowell, 1980; Iwata, Roscoe, Zarcone, & Richman, 2002). In an applied setting, where all other options have been exhausted and the animal’s quality of life is questionable, a combination therapy approach to SIB may be the most practical, ethical, and effective approach. Combination therapy utilizes a holistic, multifaceted approach that can be modified and tailored to each individual’s needs and treat many factors potentially contributing to SIB. Combination therapy can treat underlying physiological dysfunction, address environmental over- or understimulation, increase social acuity, strengthen environmental and behavioral competency, reduce stress and arousal levels, and teach appropriate coping mechanisms and more desirable behavioral responses—thus diminishing abnormal behaviors such as SIB.
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