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Functional Analysis and Treatment of Self-Injurious Feather Plucking in a Black Vulture (Coragyps atratus)

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Functional Analysis and Treatment of Self-Injurious Feather Plucking in a Black Vulture (*Coragyps atratus*)

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Dedication/Acknowledgements

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Abstract

Feather plucking (FP) is a maladaptive behavior observed in captive avian species. This self-injurious behavior results in damage to and removal of feathers and skin tissue, resulting in animal welfare and financial consequences. The etiology and maintenance of FP have been hypothesized through medical and environmental processes, yet a definitive solution has not been found. The current study investigated the environmental variables maintaining the FP of a Black Vulture (*Coragyps atratus*), as well as evaluated a function-based treatment for this behavior. The behavior was found to be maintained by positive reinforcement in the form of contingent attention. Treatment consisted of noncontingent reinforcement. Results further demonstrate the validity of function-based assessment and treatment with captive animals.

Key Words: Black vulture, conservation behavior, feather plucking, functional analysis, self-injurious behavior, treatment

Introduction

Preening is a natural grooming behavior essential to the feather maintenance of wild and captive avian (Davis, 1999). Most avian species spend a considerable amount of time maintaining their feathers due to their importance in flight, insulation, and protection. Birds preen by using their beak to adjust and clean each feather individually. The behavior is used to align feathers, smooth them by reattaching the feathers' loose hooklets and barbs, and remove debris, such as dirt, external parasites, and excess keratin (van Zeeland et al., 2009). During normal preening, regardless of the duration, no damage to feathers or skin should occur (Seibert, 2006). The behavior is considered problematic when it results in a high rate of picking at, plucking out, or chewing on feathers (Sager, 2001). Feather plucking (FP) is a physically and socially maladaptive behavior that results in damage to feathers or skin or removal of feathers. This behavior is also known as feather picking, feather damaging behavior, and clinically as Pterotillomania. The behavior can be conceptualized as a form of self-injurious behavior, which is the act of deliberately harming the surface of one's own body (Mayo Clinic, 2015). Feather plucking is a notoriously difficult-to-manage problem behavior documented in captive birds of prey (Davis, 1999; Seibert, 2006; Smith & Forbes, 2009). While FP has been well described in captive psittacine (Parrot) birds, it has yet to be extensively studied in captive birds of prey.

While there are many benefits to captivity, it is impossible to provide captive animals with the exact experience of their wild conspecifics. Animals who lack the ability to engage in species-typical behavior due to the constraints of captivity might develop captive-specific behavior maladies such as abnormal or stereotypic behavior, including pacing, regurgitation, and self injury (Forthman & Ogden, 1992; Miller, 2012). Long-term confinement has been hypothesized to exacerbate these behaviors (Seibert, 2006). Captive animals might lack some of the social and environmental enrichment their wild conspecifics experience, but captivity is part of our society. Animals reside in captivity for numerous reasons (e.g., conservation efforts, education, entertainment, etc.) and in a wide range of facilities including zoological institutions, aquariums, conservation breeding programs, wildlife rehabilitation centers, for-profit tourism parks, and more. Further, the World Conservation Union has publicly recognized the contribution of zoos and other institutions with captive species at (a) helping sustain wild populations (Ebenhard, 1995), (b) allowing for scientific study of wild populations which guides conservation efforts, and (c) providing numerous educational experiences to the public (Miller, 2012).

Self-injurious behavior, such as FP, in zoologically institutionalized animals affects both the welfare of the animal and the social stigma and finances of the institution (Dorey, Rosales-Ruiz, Smith, & Lovelace, 2009). Aside from aesthetic consequences, extensive FP can cause more serious problems for avian. The increased metabolic demand (i.e., an increased strain on the internal biochemical processes involved in creating new feathers) placed on the bird by chronically working to replace lost feathers can increase disease susceptibility and reduce their ability to thermoregulate (Rosskopf & Woerpel, 1996). Additional consequences include blood loss, damaged soft tissue, bruising, secondary infections, and permanent damage to feather follicles that might impede the regrowth of feathers. Further, FP can result in negative impacts on social interactions with conspecifics (Rosskopf & Woerpel, 1996; Seibert, 2007; van Zeeland et al., 2009). Zoos are necessarily concerned with the health and well-being of their animals and are held to a high standard by their supporters and credentialing agencies (Maple & Segura, 2014). A solution to reduce abnormal and self-injurious behaviors, such as FP, would inherently increase the health and well-being of the captive animals.

Feather plucking, as well as additional abnormal behaviors exhibited by animals within a zoological collection, can create financial and social burdens for the housing zoo. At a minimum, self-injurious behavior causes aesthetic consequences for owners. Miller (2012) found that when animals exhibit stereotypic or self-injurious behavior, not only are visitors less likely to visit the institution in the future, they are also less likely to recommend the zoo to their family and friends. Reducing self-injurious behavior is a necessary step in ensuring visitors have a positive experience at zoological institutions, which is essential to the overarching mission of increasing visitors' interest in wildlife conservation and financially supporting the zoo (Miller, 2012).

Avian who exhibit FP also necessitate financial resources in the form of veterinary visits, pharmaceutical interventions, extended keeper-time allocation, additional therapeutic treatments aimed at decreasing the behavior, and the treatment of self-inflicted injuries (e.g., cold-laser therapy; Dorey et al., 2009). Many sources report temporary solutions to FP are available, but finding the cause of these behaviors is the ultimate solution (Davis, 1999; Miller, 2012; Smith & Forbes, 2009). To date, a behavioral solution has not been empirically studied in captive vultures.

Review of Literature

Assessment of Feather Plucking

Current literature associates abnormal behavior in avian to a range of medical (Koski, 2002; Smith & Forbes, 2009) and environmental variables (Gaskins & Hungerford, 2014; van Zeeland et al., 2009). This literature is crucial for understanding the appropriate treatment for FP.

Medical Assessment. In psittacine birds, dermatologic problems are often clinically hypothesized to cause FP (Koski, 2002). Many species of ectoparasites, such as lice and mites, can infest birds. Lice are known to cause severe itching and hyperkeratosis (a thickening of the skin), while mites inhabit feathers, quills, skin, and the subcutaneous tissue of birds causing irritation that could lead to maladaptive behavior (Koski, 2002). Cutaneous infections/diseases, such as bacterial or fungal infections and avian pox (Avipoxvirus), have also been hypothesized to contribute to FP due to irritation caused by swelling and lesions. Finally, allergies to food or environmental toxins could contribute to FP (Davis, 1999), as preliminary studies noted a difference between normal and self-mutilating psittacine birds in their reactions to various allergens (Koski, 2002).

Internal maladies are commonly studied to explain the development and maintenance of FP. Malnutrition (e.g., deficiency of vitamins A & E, zinc, salt, folic acid, and biotin), liver and kidney disease, or neurochemical abnormalities could cause the origination or continuation of FP (Koski, 2002; Seibert, 2006). Although avian studies looking at FP and neurochemical abnormalities are in their infancy, based on findings in alternate species, neurotransmitters of interest include dopamine, serotonin, and opioids (Seibert, 2006). For example, van Hierden, de Boer, Koolhaas, & Korte (2004) hypothesized the FP of laying hens was contributed to neurological issues (i.e., internal physiology). These authors successfully increased FP through pharmaceutical serotonin supplementation, affirming that altering the neurobiology of the hens affected the rate of FP. The ability to increase the rate of behavior through a pharmacological variable increases the likelihood of future treatments having success by addressing that variable.

The medical diagnosis pertaining to the variable causing FP is often accomplished using a process of elimination; infection, disease, and other maladies are ruled in or out by performing a series of tests (Lamberski, 1995). This can be accomplished by having a veterinarian perform a complete physical examination, including blood chemistry and fecal floating tests. After the avian has been medically cleared and any necessary medical treatment has been completed, the

FP should be treated behaviorally (Davis, 1999). Davis suggested the use of a behavior analyst to help determine the environmental factors that contribute to the problem behavior, such as pleasurable sensations, human attention, and escape from aversive conditions (i.e., “stress”).

Behavioral Assessment. Jones (2005) noted animals who have been in captivity for extended periods of time or are placed in stressful situations due to captivity are reported to have an increased likelihood of developing maladaptive behaviors, such as FP. Specifically, the author mentioned variables such as deprivation of social interaction, loud noises, and being placed in unfamiliar environments as potential evocative environmental arrangements. A lack of environmental stimulation or social interaction might contribute to abnormal behavior in captive species (Jones, 2005; Miller, 2012; Seibert, 2006). Further, Smith and Forbes (2009) reported raptors residing in solitary aviary are more likely to engage in FP compared to those housed socially. This might align with an automatic function for problem behavior (Iwata, Dorsey, Slifer, Bauman, & Richman, 1994). Variables such as loud noises or unfamiliar environments might mirror demand scenarios in behavior-analytic research (Iwata et al., 1994). Over their lifetime, captive avian are exposed to numerous environmental stimuli that could be labeled as aversive such as, close proximity to other species, construction, changes in diet, human handling, and more.

A lack of treatment for FP could be due to the difficulty in identifying the antecedents and consequences associated with the behavior (van Zealand et al., 2009). Feather plucking has not been empirically studied within behavior-analytic research, but other maladaptive behaviors, such as self-biting, hair pulling, and human-directed aggression have been studied in non-human primates (Dorey et al., 2009; Iwata et al., 1994; Martin, Bloomsmith, Kelley, Marr, & Maple, 2011). Dorey et al. used the functional-analysis procedure (Iwata et al., 1994) to identify the variables maintaining the self-injurious behavior of a captive baboon, and Martin et al. used the functional analysis to identify the reason for the maladaptive behavior of human-directed fecal throwing and spitting by a chimpanzee. Both studies determined problem behavior was maintained by positive reinforcement in the form of contingent attention. There have been no studies demonstrating the efficacy of the functional-analysis procedure with animals other than non-human primates. van Zeeland et al. advocated for empirical studies aimed at determining the mechanisms underlying FP as a basis for treatment strategies.

Treatment of Feather Plucking

Drug Treatments. Pharmaceutical interventions have successfully reduced the rate of FP (Seibert, Crowell-Davis, Wilson, & Ritchie, 2004; van Hierden et al., 2004). Many drugs have influenced the levels of one or more neurotransmitters (e.g., serotonin and dopamine) in the brain (van Zeeland et al., 2009). The receptor antagonist, Haloperidol (Kjaer, Hjarvard, Jensen, Hanson-Moller, & Naesbye, 2004); serotoninergic reuptake inhibitors, Paroxetine (Ravindran, Lapierre, & Anisman, 1999) and Fluoxetine (Mertens, 1997); as well as hormone-altering drugs, such as Lupron and hCG (Seibert, 2007), have all been used to treat FP in single cases.

In another successful study, an anti-anxiety medication traditionally used by humans, Clomipramine, was determined to reduce the FP of cockatoos after only three weeks (Seibert et al., 2004). An additional study found responding to varying Clomipramine doses was idiosyncratic, with some birds showing a reduction in problem behavior and others remaining unaffected. Reported side effects included drowsiness, impaired balance and coordination (ataxia), change in body weight, anorexia, and posttreatment regurgitation (Ramsay & Grindlinger, 1994).

In the above-mentioned studies, although the behavior was indicated to decrease, the pharmacological treatments used were not a comprehensive solution as they potentially masked the symptoms instead of treating the underlying condition in the long term (Mills & Luescher, 2006). While severe FP might warrant the use of sedatives, these treatments should only be a temporary solution as little is known of their long-term physical and psychological effects (Davis, 1999; Seibert, 2007). Further, limited empirical data regarding dosage ranges, efficacy, safety, and toxicity are available for most off-label psychoactive drugs common in veterinary medicine (Seibert, 2007). Finally, drug therapies might be considered a form of chemical restraint, which is inappropriate as a treatment on its own (Webber, McVilly, & Chan, 2011). This type of intervention should always be implemented alongside reinforcement techniques (Vollmer, 2011); see discussion below. Seibert agreed, explaining the use of pharmacological treatments is appropriate only when the drugs are used in combination with appropriate behavior-modification treatments.

Punishment Treatments. Aversive tasting sprays (e.g., Feather Glo®, Hot Pick®, Bitter Apple®, etc.) are commonly marketed to pet owners and zoological institutions as a treatment to reduce FP and allow for feather regrowth. These commercially available sprays have been found to reduce self-injurious plucking on an individual basis, but anti-plucking sprays should be used for short durations and the underlying causes of the behavior need to be addressed. Further empirical evidence for their use is necessary (Hawkins et al., 2003).

External devices have also been used to impede the possibility of FP. Restraint collars are the most commonly used and marketed blocking device; they have been used with multiple species to impede self-injurious behavior (Brown, 2006). Unfortunately, unless the environmental variables maintaining the behavior are eliminated while the collar is worn, the behavior will resume upon its removal (Davis, 1999). Smith and Forbes (2009) developed a temporary beak-modification technique to prevent FP in three Harris' Hawks (*Parabuteo unicinctus*). The raptors were placed under anesthesia and an acrylic fixture was attached to the tips of their beaks. This was accomplished by drilling a hole in the tip of the upper beak through which a wire was guided to anchor the hand-formed round mass of dental acrylic. The treatment was successful at preventing all subjects from engaging in FP while the beak modification was in place. This device treats FP, but it does not allow for necessary and appropriate behavior, like preening, to occur because it modifies the function of the beak. The authors warned this technique should not to be used in cases where the underlying cause of the behavior has not been addressed or if a husbandry change (i.e., altering the cleaning schedule, materials in the environment, diet, etc.) could treat the behavior instead.

While the procedure used by Smith and Forbes (2009) as well as other blocking techniques have successfully reduced FP, results were only seen while devices were worn by the subjects. External blocking devices can have negative effects on the welfare of the animal, including loss of body weight and shock-induced hypothermia (Brown, 2006). This aligns with the position of the Association for Behavior Analysis International (Vollmer, 2011) on the use of restraint and seclusion. The Association for Behavior Analysis International opposes the use of restraint, except in rare cases to prevent uncontrollable problem behavior. To remain within ethical guidelines, a reinforcement-based procedure and objective data collection pertaining to the efficacy of treatment must be used in conjunction with these procedures. Additionally, the use of restraint must be reduced and eliminated when possible as they are temporary fixes to a problem that necessitates longer-term solutions.

Reinforcement Treatments. While zoological institutions provide enrichment and often work to create enclosures that mimic the animals' natural ecological habitat, these institutions lack the ability to replicate the infinite number of variables in place in the wild. Environmental enrichment is the widespread practice of introducing a variety of stimuli to the animal's environment, or changing the environment itself to increase physical activity and promote an animal's full range of natural behavior (Delfour & Beyer, 2012; Mace et al., 2010). It is suspected that enriching the environment and providing other mental stimulation will prevent birds from becoming under stimulated and engaging in aberrant behavior such as FP (Smith & Forbes, 2009).

van Hoek and King (1997) examined the effect of environmental enrichment on FP in a collection of Crimson-bellied Conures (*Pyrrhura perlata perlata*). The enrichment consisted of edible and non-edible tangibles and the relocation of the birds' perches. They found the enrichment successfully increased alternate behavior, such as locomotion and the manipulation of items. They determined the treatment did not alleviate FP as no improvement to the plumage was visible during or after the enriched periods. The lack of change to FP could be because the function of the behavior was not properly identified.

In an additional enrichment study, Meehan, Millam, and Mench (2003) assessed the ability of environmental enrichment to prevent or reduce the development of FP in parrots. Feather plucking was seen in a group of parrots raised in an austere environment deprived of enrichment. Re-feathering began soon after providing foraging substrates and increasing the physical complexity of the enclosures. Austere environments are in violation of the American Zoological Association's (AZA) enrichment program standards for housing avian. Institutions must have a formal written enrichment program aimed at promoting species-appropriate behavioral opportunities (AZA Accreditation Standard 1.6.1). As AZA accredited facilities must adhere to this standard, it is unlikely that FP would develop in a similar fashion as subjects within this study.

In the two behavior-analytic studies exploring reinforcement-based treatments for the problem behavior of animals, differential reinforcement of alternative behavior (DRA; Dorey et al., 2009; Martin et al., 2011) was used to treat the self-injurious behavior of a baboon and human-directed aggression of a chimpanzee. In both cases, problem behavior was found to be maintained by attention; therefore, attention was delivered for an alternative response, and no attention was given for the problem behavior (i.e., problem behavior was placed on extinction). Both studies successfully extinguished problem behavior; however, no similar studies have been conducted with captive avian.

Statement of the Problem

Feathers are essential for flight and provide additional benefits, such as insulation and bodily protection for avian species. Current literature on FP covers pharmaceutical (i.e., medical) and environmental treatments. A reinforcement-based behavioral approach has yet to be empirically studied with avian, specifically captive vultures. Along with improving the wellbeing of the bird and decreasing resources necessary for the zoological facility, the eradication of maladaptive behavior such as FP in captive species could aid the conservation efforts of endangered wild conspecifics. For instance, the California Condor (*Gymnogyps Californianus*) is a New World vulture defined as *Critically Endangered* by the International Union for Conservation of Nature and Natural Resources (IUCN). Once extinct in the wild, an intensive conservation program including reintroduction and release of captive-bred birds has created a small, yet increasing, wild population still dependent on conservation management efforts

(Birdlife International *Gymnogyps*, 2016). Maladaptive behaviors within captivity can result in birds being deemed unreleasable (Meretsky, Snyder, Beissinger, Clendenen, & Wiley, 2000). Developing function-based assessments and treatments could increase the number of reintroduced animals, thus genetically strengthening wild populations.

Behavior-analytic researchers have empirically studied the maintaining variables related to self-injurious behavior (Dorey et al., 2009) and aggression (Martin et al., 2011) in captive primates. Additional behavioral research is needed with captive animals to understand why they engage in maladaptive behavior and to determine function-based treatments to effectively decrease these problems. A behavioral assessment and treatment could increase the welfare of avian while also increasing the financial stability of institutions by decreasing necessary resources to deal with these problems. The current study is the first extension of functional-analysis principles (Iwata et al., 1994) to assess potential maintaining variables for self-injurious behavior outside of human and non-human primates and subsequently use them to decrease the problematic behavior.

Method

Subject and Setting

A 10-year-old male black vulture (*Coragyps atratus*) named Lurch was the subject of this study. Wild-born, Lurch was received from the wild as an orphaned chick. Over the course of being hand-reared, Lurch became imprinted on his caretakers; Thus, he was deemed unreleasable, at which point he was adopted by the Silver Springs Zoo in Florida as an educational bird. When the facility closed, he was relocated to where he was housed for the current study, at the Central Florida Zoo in Sanford, FL. Here, he continued to work as an educational ambassador until the extent of his self injury removed him from public display.

Keepers stated Lurch had been engaging in FP since before his relocation; the exact timeframe was unknown.

The subject was recommended for this study by zoo personnel, as the avian had a long history of engaging in FP to the extent it was considered by the zoo staff to be self-injurious behavior. Staff veterinarians had concluded Lurch was healthy and not engaging in FP for medical reasons; his health was routinely examined. At the time of this evaluation, the avian was missing a substantial number of feathers on his left shoulder and had caused extensive damage to feathers on his underwing and lower body. His left shoulder had subdermal damage due to plucking at his skin, exposing tendons and often caused bleeding because of FP. A variety of treatments had been administered to mitigate the behavior with limited success; his caretakers tried topical ointments, blocking collars, social and tangible environmental enrichment, relocating his enclosure, and cold-laser therapy. One reason these approaches were not successful might have been that previous treatment attempts had not identified the environmental variable responsible for Lurch's FP.

Lurch was housed alone in an 8 ft by 10 ft outdoor enclosure in an off-exhibit area at the Central Florida Zoo where he remained throughout all experimental sessions. The rectangular enclosure was composed of a natural dirt and mulch floor and had chain-link fencing. His enclosure contained two natural wood perches, a mue (wooden 5 ft by 5 ft night house), and a man-made box. Lurch was surrounded on three of his enclosure walls by psittacine birds, other small birds of prey, and an opossum less than 3 feet away. The remaining wall was free of visual obstructions, creating a clear line of sight for observation (Appendix A). Lurch received indoor flight access and an extensive enrichment schedule that abided by the recommendations determined by the AZA aimed at increasing species-specific behavior. There were no changes to the daily care or husbandry of the subject. These tasks were completed by the zoo keepers and were not the responsibility of the author of this study.

Response Measurement and Interobserver Agreement

The percentage of intervals of *feather plucking* (FP) was recorded as the target behavior. Feather plucking was defined as any instance of the beak closing around a feather and either pulling in the opposite direction of the skin or biting down at least two times in the same bodily quadrant. Data were analyzed by calculating the percent of occurrence or nonoccurrence of FP in ten-second intervals within each 10-min condition.

All sessions were videotaped. Live and videotaped data were collected on the target behavior across conditions. Interobserver agreement (IOA) was assessed by comparing the records of two observers who independently scored 43% of sessions. Data were collected via an electric handheld device using the Instant Data PC (Version 1.4). The observers' records were compared using an interval-based exact-agreement method. An agreement score per interval was calculated by determining the percentage of intervals in which each observer independently recorded or did not record behavior in agreement. The interval agreements were then averaged, resulting in a 95% mean IOA (range, 72% to 100%) for the target behavior.

Paired-Stimulus Preference Assessment

A paired-stimulus preference assessment (PSPA; Fisher et al., 1992) was used to determine preferred edibles, as this method was empirically found to be more accurate in identifying highly preferred stimuli over the single-stimulus method for other animal species (Fernandez, Dorey, & Rosales-Ruiz, 2004). Five food items from the subject's normal diet and enrichment schedule were used: Zoo Prime (i.e., nutritional avian pellet feed), strawberries, meat cubes, ground carnivore meat (i.e., horse carcass), and mice chunks. Meat cubes, strawberries, and mice chunks were presented in approximately 1 x 1 x 1 centimeter pieces, zoo prime pellets were cut in half and soaked in water (per normal preparation methods), and carnivore meat was presented in spheres 1 cm in diameter. Prior to the assessment, Lurch had the opportunity to sample each of the food items individually to ensure familiarity with the items and their presentation.

During the assessment, all items were presented in pairs 1 ft apart using a pair of metal tongs (Fernandez et al., 2004). Each food item was paired with every other food item twice for a total of 20 trials. To begin a trial, Lurch was at least 3 ft from the tongs. A selection was scored on each trial where the vulture removed one item from the tongs and consumed it. If no food item was consumed within 5 s, the experimenter removed the items for 5 s before representing them in the same positions. If no selection was made on the second presentation, the trial was terminated. This did not occur during the assessment, but would have been the procedure if the circumstance arose. Data were collected by recording the food item selected and lateral side from which it was selected. These data are presented in Figure 1. Mice chunks were selected in the most trials (100%), thus were defined as most preferred. The other items in order of most to least preferred were, carnivore meat (75%), chunk meat (50%), strawberries (25%), and Zoo Prime (0%).

General Procedures

All sessions were 10 min; eight to 12 sessions were conducted per day, over the course of three days. The experimenter and observer collected data 3 to 5 ft away from the subject, positioned between the largest exposed side of the enclosure and a parallel privacy fence (see ‘X’ on Appendix A). If at any time a caretaker believed the health of the subject to be at risk, he or she could terminate the session; at that point, the avian would have been medically cleared by the zoo's veterinary staff prior to proceeding. This did not occur over the course of the experiment.

Functional Analysis. Four conditions (control, alone, tangible, and attention) were alternated in a random order in a multielement design to determine potential maintaining contingencies for FP. Conditions were selected based on anecdotal information gained from multiple caretakers (e.g., the enclosure was moved closer to people because the keepers stated Lurch liked to be close to humans and needed a distraction). As Lurch was given treats while performing in educational shows, during training sessions, and in the form of environmental enrichment, a tangible condition was included to determine if the delivery of edibles influenced his FP. Caretakers indicated he did not engage in the behavior while under the demand of shows or during training sessions due to his 'focus' on the human trainer, thus an escape condition was not included. The experimenter and observer wore colored shirts determined by the condition; these were implemented to help the subject discriminate between the conditions (Conners et al., 2000).

The *control* condition consisted of Lurch receiving food and attention on fixed-time (FT) intervals noncontingently. The experimenter delivered the food item determined to be the most preferred in the paired-stimulus preference assessment (i.e., mouse chunks) and attention in the form of brief verbal praise (e.g., "You're so smart" or "Hey handsome bird") on alternating 15-s schedules. This condition was expected to result in low levels of plucking if social variables were responsible for maintaining the behavior. No consequences were delivered contingent upon FP.

The *alone* condition consisted of Lurch being in his enclosure without access to additional enrichment items or human attention. Within this condition, the experimenter and observer remained out of the subject's sight and recorded data from videos of the sessions. No consequences were delivered contingent upon FP. This condition was conducted to determine if the behavior persisted in an austere environment.

During the *tangible* condition, Lurch remained in his enclosure without access to human attention and a portion of mice chuck was delivered contingent on FP using the metal tongs used in the preference assessment. This condition was conducted to determine if the behavior was being maintained by positive reinforcement in the form of edible items.

For the duration of the *attention* condition, human attention was only given for FP. The experimenter remained in front of the enclosure facing away from the subject. Contingent on FP, the experimenter turned toward the subject and delivered statements of concern or reprimands (e.g., “Aww, Lurch” or “Stop plucking handsome”) for 3 to 5 s. This condition was conducted to determine whether FP was maintained by positive reinforcement in the form of social attention.

Treatment Analysis. The functional-analysis condition with the highest rate of behavior was used as the initial baseline (i.e., the attention condition). Treatment was evaluated in a subsequent withdrawal design. As the rate of FP and the severity of the injuries suffered were substantial, a noncontingent-reinforcement procedure was used to reduce the behavior. This treatment was identical to the control condition of the functional analysis. The highly preferred edible item (mice chunks) and attention were delivered noncontingently on alternating FT 15-s schedules. In addition, no consequences were delivered for FP, meaning extinction was in place. Once treatment effects were obtained, we reversed back to baseline and reintroduced treatment in an ABAB design.

Results

As previously discussed, Figure 1 depicts selections in the PSPA. Mice chunks were selected on every trial in which they were presented (M = 100%), thus mice chunks were deemed to be most preferred. All other items were selected on fewer trials: carnivore meat (M = 75%), chunk meat (M = 50%), strawberries (M = 25%), and zoo prime (M = 0%), respectively.

Figure 2 depicts the results of the functional analysis, in which the highest level of FP occurred in the attention condition (M = 48% of 10-s intervals) and the lowest level of FP occurred in the control condition (M = 0% of 10-s intervals). While some FP occurred in the alone condition of the functional analysis initially, problem behavior in that condition dropped off by session 13 and remained low for the remainder of the assessment. The results suggested FP was maintained by positive reinforcement in the form of contingent attention.

Figure 3 demonstrates the results of the treatment analysis, comparing levels of FP in baseline and treatment conditions. The first baseline consisted of the attention sessions from the functional analysis with mean FP at 48%. The treatment consisted of noncontingent reinforcement (NCR) in the form of human verbal attention and mice chunks delivered on alternating 15-s schedules (as well as extinction) and resulted in zero instances of FP. Upon our reversal to baseline, mean FP increased to 62% followed subsequently by a replication of zero levels of FP in treatment.

Discussion

The results of the functional analysis suggested Lurch's self-injurious FP was primarily maintained by positive reinforcement in the form of human attention. The success of the treatment package, which included freely delivered human attention, supports the efficacy of the functional analysis as an assessment tool for identifying the maintaining function(s) of problem behavior in captive species. This adds to previous literature by applying the functional assessment to a population outside of human and non-human primates. The author intends to thin the schedule of NCR, determine if attention or tangibles are the more effective treatment component, and possibly include a DRA treatment component in aims of achieving sustained behavioral reduction for this subject.

Having a method to develop function-based treatments for abnormal behavior could increase the likelihood of release for rehabilitated animals and those bred for species reintroduction programs. The subjects in these programs are unlikely to be selected for reintroduction, despite their genetic rarity, if they engage in behavior that could diminish their chance of surviving in the wild. Additionally, the ability to reduce or eradicate these behaviors would positively impact the lives of countless captive animals while increasing the finances of the institutions that house them.

Due to AZA accreditation standards aimed at providing the avian with an environment that promotes its well-being, the daily enrichment schedule was not removed during the study. As environmental enrichment is aimed at increasing species-specific behavior and reducing maladaptive behavior, this might have had an impact on treatment results; although the enrichment schedule was in place prior to analysis and treatment when FP continued to occur. Further this variable was in place across all conditions, including baseline. Additionally, unforeseen environmental variations, such as new staff members, changes to daily routine per special events and educational tours, and seasonal temperature changes occurred due to the uncontrollable nature of the zoological facility, as compared to the highly-controlled environment of a laboratory.

Future studies should examine the ability of function-based treatments, developed on common species (i.e., species of Least Concern as determined by the International Union for Conservation of Nature and Natural Resources based on species population sizes (total & mature), generation length, population trends, health of habitat, etc.) to be used on maladaptive behavior in conspecifics ranking higher on endangered species lists. In situ and ex situ conservation efforts such as the ‘Alala (*Corvus hawaiiensis*) Recovery Plan (U.S. Fish & Wildlife Service, 2009) and the California Condor Project (U.S. Fish & Wildlife Service, 2016), respectively, detail the types of conservation efforts that could most likely benefit from future studies. Additionally, in aims of increased welfare and advancing behavior analysis in zoos and aquariums, studies should apply functional analyses and function-based treatments to a wider demographic of captive species and behavioral maladies.

The current study is the first to demonstrate the utility of the functional analysis in the assessment and treatment of self-injurious behavior in a species outside of human and non-human primates. This method could impact the welfare of zoological animals exhibiting maladaptive behavior and decrease the rate at which maladaptive behavior hinders the efforts of rehabilitation centers and conservation projects.

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Appendix A. Arial view of enclosure. Data collector and therapist location indicated by 'X.'

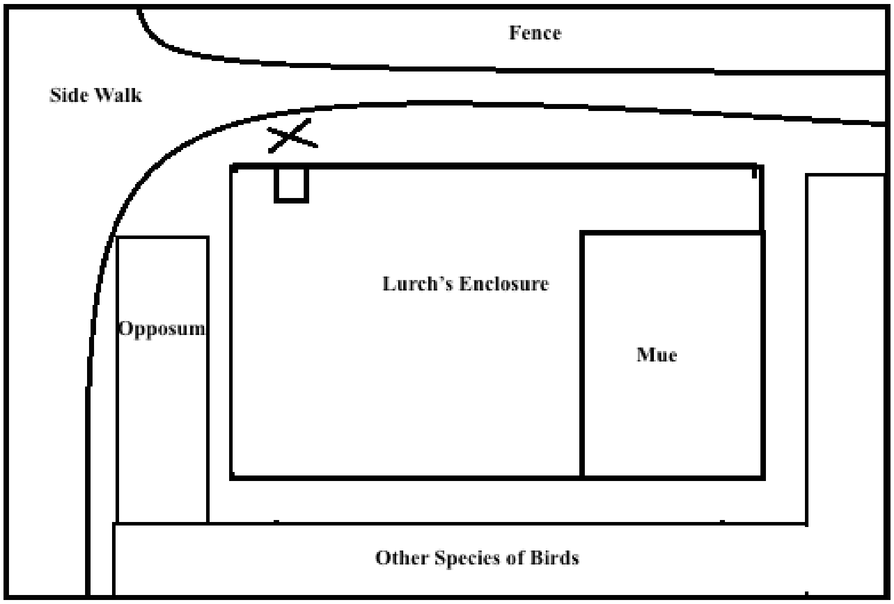

Figure 1. Preference assessment results.

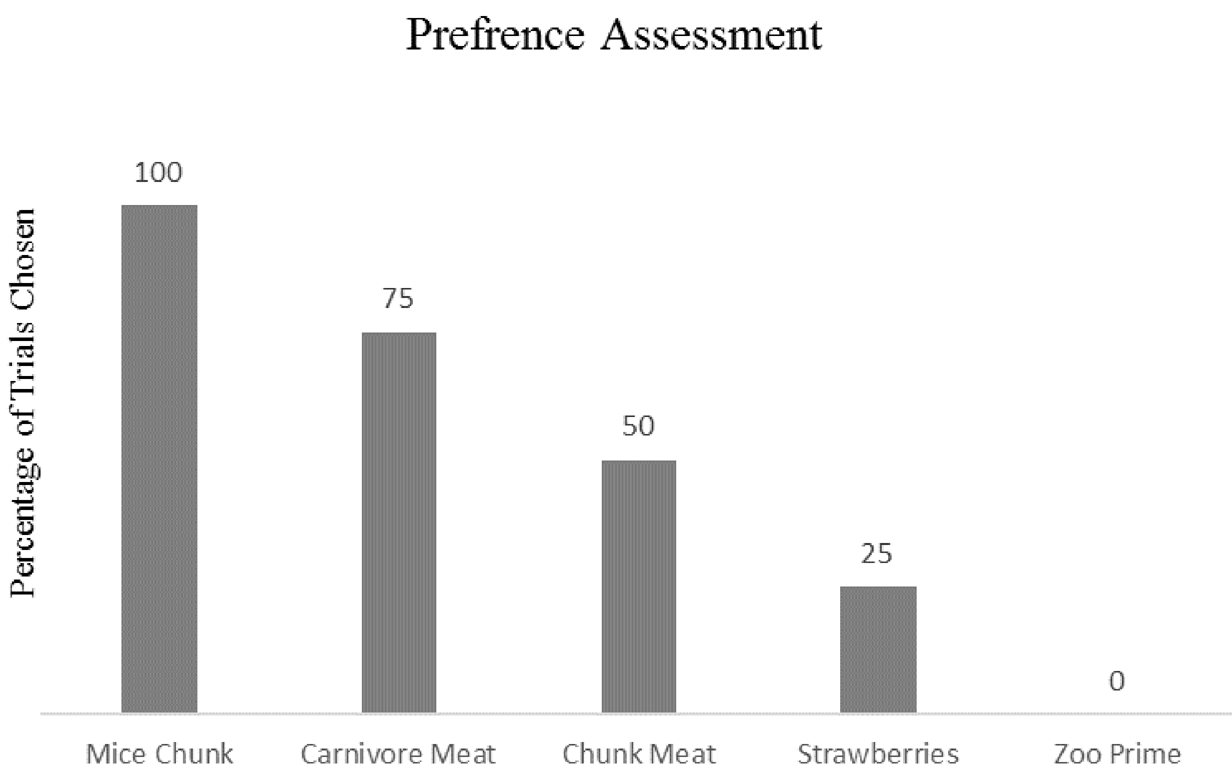

Figure 2. Percent of 10-s intervals with feather plucking in the functional analysis.

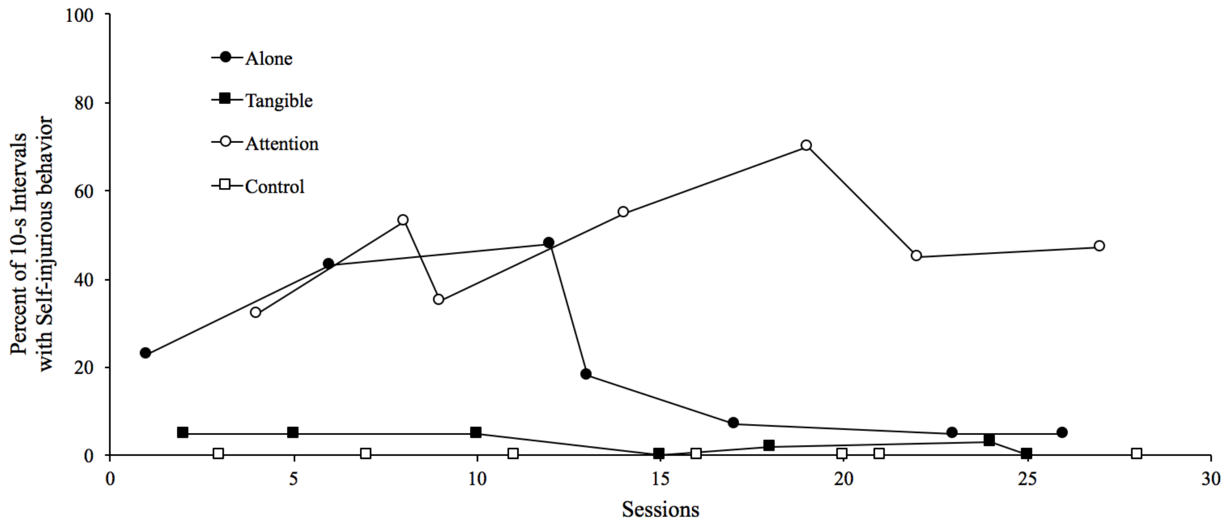

Figure 3. Percent of 10-s intervals with feather plucking in the treatment analysis.