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Effects of Constructional Aggression Treatment (CAT) on Aggressive Displays by a Hybrid Orangutan

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Abstract

Animals in captivity engage in a variety of undesired behaviors, including aggression. Animal caregivers have used functional analyses to determine the function of the animal's behavior in order to teach replacement behaviors. One function of behavior that is often associated with aggression is escape. Constructional aggression treatment (CAT) has been shown to be effective in teaching replacement behaviors for escape-maintained aggression. This study used CAT which entails shaping through negative reinforcement to reduce aggressive behaviors in an adult orangutan in a zoo setting. The orangutan's aggressive behaviors decreased while alternative, appropriate behaviors increased. Aggressive displays remained at a low level, and alternative behaviors maintained during maintenance trials. This was demonstrated across time and across three non-preferred individuals indicating the results generalize and maintain.

Keywords: Constructional aggression treatment, orangutan, negative reinforcement, shaping, aggression

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Animals housed in zoo settings sometimes exhibit undesirable behavior toward caregivers or visitors, such as banging, posturing, screaming, and engaging in aggressive displays (Martin et al., 2011). Animals in petting zoos may engage in ramming, charging, running away, or head-butting (Anderson et al., 2002). These behaviors can have negative effects on both animals and humans. For the animals, undesirable behaviors can result in decreased animal welfare (Waiblinger et al., 2006) or cause possible injury to themselves or other animals (Rommeck et al., 2006). For humans, undesirable behaviors may result in safety concerns and attitude shifts for caregivers, leading to negative interactions between animals and humans (Waiblinger et al., 2006). Research suggests that these behaviors may negatively impact a person's future attitudes toward animals (Kidd & Kidd, 1995). It is therefore in the best interest of the animal, caretaker, and visitors that these behaviors be addressed.

But how should these behaviors be addressed? From a behavioral point of view, any operant behavior that occurs repeatedly serves some function. If the function of the undesirable behavior can be identified, one could then modify the environment to change its functionality, and therefore reduce the problematic behavior (Feuerbacher & Wynne, 2016). One way to identify the potential function (maintaining consequence) of a behavior is through a functional analysis.

Functional analyses are commonly used to identify the function of various behaviors (Iwata et al., 1994). In a typical analysis, the programmed consequences (conditions) are tested separately and typically include the following conditions: alone, attention, demand, play/control, and tangible (Iwata & Dozier, 2008). Each specified contingency is set in place during a condition and the rates of behavior observed across all conditions are compared. The condition(s) with the highest rate of behavior are hypothesized to be the function of the behavior of the subject (see Iwata & Dozier, 2008 for more detailed information). For example, attention may be deemed the maintaining consequence if when attention is provided contingent upon the behavior it produces higher rates of the behavior of interest than other types of consequences (e.g., tangibles, escape). These analyses help researchers determine the maintaining consequences for specific (usually problematic) behaviors and the results can be used to create individualized behavior change (Iwata & Dozier, 2008).

Functional analyses are well established in humans (Broussard & Northup, 1997; Hanley et al., 2003; Jessel et al., 2020), and they are becoming more established with animals. The first published functional analysis in an applied animal setting was by Dorey and colleagues (2009). The researchers preprogrammed different consequences (e.g., ignore, attention, demand, play, and tangible) to compare the rates of self-injurious behavior (e.g., hair-picking) in an olive baboon. The authors found that rates of self-injurious behavior were highest when attention was provided contingent upon the behavior. Given this information, the authors then worked to identify an alternative, more appropriate, response. When social attention was provided for lip-smacking, lip-smacking increased while the hair-picking behavior decreased. By identifying the maintaining consequence of the self-injurious behavior (e.g., attention), the authors were then able to provide this consequence contingent on a more desirable behavior (e.g., lip smacking), thereby decreasing self-injurious behavior.

Another example of a functional analysis used with non-human animals was conducted by Martin and colleagues in 2011. Researchers found that the chimpanzee's feces throwing, spitting, and screaming were maintained by attention (Martin et al., 2011). Like the outcome of the Dorey et al. (2009) study, when attention was only provided contingent upon the display of an alternative, more acceptable behavior, the maladaptive behaviors decreased by 90% (Martin et al., 2011).

Though both studies found attention to be the maintaining consequence of the undesirable behavior, there are other consequences that may maintain behavior, such as access to desired items or individuals, sensory stimulation, and the escape from or avoidance of an aversive stimulus (see Feuerbacher & Wynne, 2016 and Morris & Slocum, 2019 for examples). Regardless of the consequence, if the function of a behavior can be identified, the maintaining contingencies can be altered to support more desirable behaviors. This approach focuses on building new desirable behavior to replace other, less desirable behavior instead of focusing on simply decreasing the problem behavior directly (such as using punishment or extinction). This has been referred to as a constructional approach to behavior modification (Goldiamond, 1975). The constructional approach has been taken to replace many undesirable behaviors, including aggression.

Aggressive behavior may be defined as physical attacks, confrontation, and/or hostility. Though these terms are not often associated with fear, some early ethological approaches to aggression suggest that an animal's natural reaction is to either engage in flight (e.g., running away) or fight (e.g., aggression) behavior when danger is too near (Lorenz & Wilson, 1966). This suggests that fear may be an underlying motivation for aggression, and from a behavioral perspective, may be maintained by escape, or distance, from the stimulus. As discussed previously, if the function of a behavior is known or hypothesized, then it is possible to change the environmental contingencies in a way to provide the desired outcome (in this case distance or removal of aversive stimulus) contingent upon desired behavior, and not for the undesired behavior (aggression).

The Constructional Aggression Treatment (CAT) was first developed by Snider (2007) and is meant to build and replace aggressive behaviors by altering the maintaining contingencies to support more appropriate/desirable behaviors. This procedure utilizes two behavioral processes to gradually build more appropriate behaviors, shaping and negative reinforcement. Both processes will be discussed individually as well as how shaping with negative reinforcement work together in the CAT procedure.

Shaping

Shaping is the process of differentially reinforcing successive approximations toward a desired target behavior (Skinner, 1953). Early in the process, any approximation (or step) towards the target behavior is reinforced. Once an approximation is occurring regularly, reinforcement is withheld. This brief period of extinction produces behavioral variability. It is this variability that can be reinforced to create new approximations. As the approximations become closer to the target behavior, previous approximations are no longer reinforced (see Peterson, 2004 & Skinner, 1953 for examples). Shaping has been used to decrease self-injurious head banging behaviors in monkeys (Schaefer, 1970), develop lever pressing by rats (Powell et al., 1968), and to teach porcupines to hold a target response (Fernandez & Dorey, 2020). Shaping is an evidence-based procedure that can produce complex behaviors by focusing on what the organism is currently offering and building upon these behaviors using differential reinforcement contingencies. Though shaping is generally thought of as the progression of successive approximations using positive reinforcement, this process can also be achieved using negative reinforcement.

Negative Reinforcement

In a negative reinforcement contingency, the consequence of removing, stopping, or avoidance of a stimulus results in an increase in behavior (Rachlin & Hineline, 1967). Techniques such as spraying water behind an animal, using loud voices or noises, or threatening an animal with a dart gun to get them to move to a new location (Perlman et al., 2012) are all examples of negative reinforcement. Other, less aversive, examples of negative reinforcement include putting light pressure on the reins of a horse, or pressure with a rider's legs to guide horses (McLean, 2005).

Shaping with Negative Reinforcement

When shaping with negative reinforcement, the stimulus (e.g., pressure on reins or animal's body) is removed contingent upon a desired response (e.g., slowing down) in systematic approximations to a terminal behavior. Shaping with negative reinforcement has been used to teach llamas (Kurland, 2000) and sheep (Fernandez, 2020) to approach humans. At the start of training, these animals would move away from any human, but when a contingency was put in place in which the humans would provide distance between themselves and the animal (removal of aversive stimulus) contingent upon an approach behavior, the animals began willingly approaching the experimenters. Once the approach response was occurring reliably, the experimenters were able to transition to the use of positive reinforcement (e.g., food) for approach behaviors. In these examples, the animal's avoidance behavior was maintained by the consequence of the removal of the stimulus (the experimenter). When the environment changed in such a way that the consequence of the removal of the experimenter was now made contingent upon, not moving away, but approaching, approaching behavior increased. Much like fearful behaviors, it has been hypothesized that aggressive behaviors (growling, baring teeth, posturing, etc.) may be maintained by negative reinforcement. That is, aggressive behaviors may serve to put distance between the aggressor and the provoking stimulus.

Snider (2007) tested this hypothesis by testing whether distance (removal of a stimulus) could be used to shape desirable, alternative behaviors to replace aggressive responses in dogs. This procedure, known as the constructional aggressive treatment (CAT) presents the putative aversive stimulus or provoking stimulus (e.g., other animals, unfamiliar people) to the dog at a sub-threshold level. That is, the stimulus is presented at a distance in which the subject can see the stimulus, but it does not produce an aggressive response. Once the dog provides an appropriate, alternative behavior (e.g., approaching, laying down, head tipping, licking, sniffing, turning away, walking away, yawning) the provoking stimulus is removed (Snider, 2007). If the removal of the provoking stimulus is indeed a negative reinforcer, one should see the frequency of these alternative behaviors increase. After a series of successful trials of the animal engaging in alternative responses, the stimulus is brought closer to the animal. In the event of an unsuccessful trial (where the animal engages in an aggressive behavior or precursor behavior) the distance from the subject to the stimulus is repeated. If aggressive responses occurred for five consecutive trials, the stimulus distance is increased by two feet in the subsequent trial (that is, the animal is given more space between them and the stimulus). If the aggressive/maladaptive response continues to occur, the stimulus is taken back to accurately reflect the sub-threshold level. The dog will remain at this level until an alternative, acceptable behavior is shown. Once the dog displays the alternative behavior, the stimulus is moved closer to the dog in the next trial. (This is a broad overview of this procedure, please see Snider [2007] for diagrams, questionnaires, and full details of the procedure.)

As the shaping process continues, specific approximations are reinforced, and therefore begin to occur more often (Peterson, 2004; Skinner, 1953). As the desired behaviors increase and the undesirable behaviors decrease, most of the animal subjects reach what is referred to by Snider (2007) as a “switchover point.” This is the point in the procedure where the animal begins to show behaviors such as accepting food, smelling, or licking the previously “aversive” stimulus. This “switchover point” has been described many times in previous research (Katz & Rosales-Ruiz, 2022; Rentfro, 2012; Snider, 2007), and though the direct mechanism for the change from aggressive to affiliative behavior toward a stimulus remains unknown, it is at this point that the procedure begins to shift from solely negative reinforcement to include positive reinforcement. Negative reinforcement may still be used, but the animal may be offered food (Fernandez, 2020; Snider, 2007) or physical attention such as petting and brushing (Katz & Rosales-Ruiz; Rentfro, 2022; Snider, 2007) for these affiliative behaviors as well.

CAT has been shown to be effective at treating aggressive behavior in dogs (Snider, 2007) and fear responses in cats (Rentfro, 2012) and dogs (Katz & Rosales-Ruiz, 2022) and, as mentioned previously, with llamas (Kurland, 2000) and sheep (Fernandez, 2020) to increase approach behaviors. However, CAT has not yet been empirically studied using exotic species or in zoological settings. The purposes of this study are to further empirically study the use of CAT, extend the procedure across settings and species, and determine if the procedure can be effective at reducing aggressive displays from a hybrid orangutan.

The subject in this study was a hybrid orangutan (*Pongo pygmaeus x Pongo abelii*) who displayed aggressive behavior in the presence of specific keepers, volunteers, zoo staff, and interns. Keepers were unable to identify why these specific individuals were the focus of these aggressive displays, as there were no physical or behavioral similarities between the individuals. For the past nine years, when a non-preferred individual entered the area, the subject began to walk in circles in his habitat, walk to the holding door, place his hands and one foot on the fencing, and sway back and forth. The subject maintained eye contact and followed the non-preferred individual as they moved throughout the area. If the non-preferred individual remained in the area for more than a few seconds, the subject escalated this behavior and began to pound the fencing with a closed fist. As soon as the individual left the area, the subject returned to normal activity.

Previous attempts to reduce the subject's aggression included providing non-contingent highly preferred edibles in the presence of non-preferred individuals and pairing preferred individuals with non-preferred individuals. Both attempts were unsuccessful at decreasing aggressive behavior in the presence of the non-preferred individuals. Concerns regarding the health and wellbeing of the subject continued to be raised due to his age and the potential harm to himself or others. At the start of the study, these aggressive displays had been going on for nine years. Since the aggressive behavior stops as soon as the non-preferred individual leaves, it was hypothesized that the function of these aggressive displays is maintained by escape from these individuals. If escape was maintaining this aggressive behavior, then changes in the environment should include providing this escape only contingent upon a more desirable behavior. The goal of this study was to reduce the number of aggressive displays and increase alternative behaviors in the presence of non-preferred individuals using the CAT procedure.

Methods

Participants

The subject is a 33-year-old hybrid orangutan (*Pongo pygmaeus x Pongo abelii*) housed at an AZA accredited zoo in the southern United States. The orangutan was hand-reared in a private home for the first portion of his life, but he has resided at the current facility since 2009. The subject is housed with an adult female orangutan. There is another adult male, adult female, and a young male orangutan who are also housed in the same night house, but the subject does not have direct interactions with the other orangutan family.

Three zoo staff members were identified as "non-preferred" by the subject. The presence of these individuals reliably produced aggressive displays by the subject. Two of these individuals have cared for the subject since he arrived at the zoo in 2009. The third has had less than one month of interaction with the subject.

Design and Measurement

A nonconcurrent multiple baseline design across different non-preferred individuals was used in this study. A nonconcurrent multiple baseline design is used when the phases with each decoy are not synchronized in real time (Kennedy, 2022). That is, baseline, intervention, and maintenance were carried out with each decoy to completion before the next decoy began baseline. Prior to the start of the experiment, the care staff identified precursors and aggressive behaviors. Precursor and aggressive behaviors included the following: swinging, throwing, swaying, banging the door, grabbing under the door, grabbing the door, jumping on the door, and blowing air (attempting to spit). The staff also identified alternative, acceptable behavior responses which included the following: sitting, standing at the door, holding the door, and walking away from the door.

Instances and duration of aggressive behavior, as well as the number of successful trials in which the subject displayed an acceptable, alternative behavior with no signs of aggression were the measures of interest. Other dependent measures for this study include the distance from the subject's stall door and the topography of the aggressive display. When the human decoy was able to get within one foot of the subject for six consecutive trials without an aggressive display, a tangible, highly desired reinforcer (one Lifesavers® candy) was delivered by the human decoy. Mastery criterion was six consecutive trials without any aggressive displays, and the acceptance and consumption of candy for Decoy 1 and increased to 12 consecutive trials for Decoys 2 and 3 to ensure mastery. Treatment was terminated for Decoys 2 and 3 when 12 successful, consecutive trials were completed at one foot from the subject and if he consumed the candy.

A trained observer collected interobserver agreement data (IOA) on 30% of the sessions with a set criterion of a minimal agreement level of 85%. During 30% of the trials, the observer and primary caregiver would signal to one another if the behavior met the acceptable behavior criteria or not. The primary investigator collected their responses. Trial-by-trial interobserver agreement was 100% across the two keepers.

All sessions were videotaped using an iPhone to observe and collect data. The recording device was mounted in such a way as to clearly record the subject and the decoy. Observations began when a decoy entered the night house and walked toward the subject. Measurement ended when the decoy was out of view at the end of each trial.

Setting

This research was conducted in the orangutan's temperature-controlled night house (where the aggressive displays occurred most often). This area consisted of six stalls, each with permanent benches, eyebolts in the wall and/or ceiling with the ability to be furnished with a firehose, hammocks, barrels, toys, etc. Each stall is approximately 12 ft. by 12 ft. and has at least two shift doors that lead to the other stalls, exhibit, or day yards. During the procedure, the stall doors were closed, which ensured the subject was unable to leave the designated stall and that the other orangutan was unable to enter this designated stall. The subject's stall consisted of various enrichment materials that changed daily such as blankets, cardboard boxes, or hay.

One of the subject's primary caregivers was present during each experimental session. The same person was present during all trials of the study for consistency. The primary keeper stood in an adjacent stall to observe the subject's behavior and indicated to the decoy when to stop, exit, or provide an edible reinforcer.

Baseline

During baseline, the decoy entered the night house and walked at a consistent pace toward the subject. As soon as the subject engaged in any aggressive behavior(s), the decoy stopped and left a marker on the floor to indicate this distance and immediately turned around and walked away taking the same path they took to approach. Once the decoy was out of sight (by turning a corner), the trial ended. There was a five-minute inter-trial interval before the next trial began. Three to five baseline trials were conducted to establish the subject's aggression threshold with each decoy. After baseline concluded, the average distance from the subject when aggression was observed was calculated and used as the starting threshold for the CAT procedure. This starting threshold was specific to each baseline phase conducted for each human decoy.

Treatment

After baseline was completed and the starting threshold for a given decoy was identified, the CAT treatment began. A marker was placed on the floor two feet behind the location that was deemed the initial threshold during baseline. For example, if the threshold calculated during baseline was six feet for a given decoy, the marker was placed eight feet away from the subject.

During the treatment procedure, the decoy entered the night house, walked toward the subject at a consistent pace, and stopped at the marker. Each decoy greeted the subject upon entry in a similar way to the preferred keepers (e.g., "Hey!", "Hi!", "Hey handsome!"). The decoy waited at this distance until one of the previously determined acceptable, alternative behavior was exhibited. If the subject engaged in one of these behaviors for three seconds, the decoy turned around and walked out of the night house. If the subject engaged in an aggressive display as the decoy was walking away, the decoy stopped and turned halfway toward the subject without engaging in direct eye contact. Once the subject engaged in an acceptable, alternative response for three seconds, the decoy continued walking out of the night house.

After each successful trial (i.e., the decoy walked to the threshold and no aggressive responding occurred for three seconds), the marker was moved one foot closer to the subject in the subsequent trial. However, if the subject engaged in an aggressive display at any time in the trial, in the following trial the decoy would walk to the previous marker. If there were five consecutive unsuccessful trials (i.e., aggressive behavior occurred), the distance the decoy approached was decreased by two feet. For example, if the subject engaged in aggressive displays at the 2-ft. marker for five consecutive trials, in the sixth trial, the human decoy would stop at the 4-ft. marker.

This shaping procedure of decreasing the distance between the decoy and the subject based on the subject's acceptable behaviors continued as described above until the decoy was able to get within one foot of the subject. Mastery criterion was set at six consecutive successful trials at this distance. On the sixth trial, the decoy placed a piece of hard candy in a predetermined location (selected for the safety of both the decoy and the subject) for the subject to retrieve. After completing the training for Decoy 1, the researchers decided to add an additional six trials to the mastery criteria to ensure that mastery was truly attained. For Decoys 2 and 3, mastery criterion was 12 consecutive successful trials at one foot as well as the subject eating the hard candy that was given by the decoy.

Maintenance and Generalization

Once the subject met mastery with a decoy, a maintenance phase was completed four to thirteen days after the initial baseline trial (the number of days was dependent on the decoy's availability). During maintenance sessions, a decoy entered the night house, greeted the subject, and walked toward his stall door. The decoy walked until either they reached the 1-ft. mark or the subject engaged in an aggressive display. The methods and mastery criterion mirrored the treatment phase.

After the subject met the criterion with a decoy in the maintenance phase, the next decoy was scheduled to begin. This was based on the decoy's availability. There were 12 days between the end of maintenance for Decoy 1 and the start of baseline for Decoy 2, and nine days in between the end of maintenance for Decoy 2 and the start of baseline for Decoy 3. Baseline, treatment, and maintenance criterion were the same for all decoys.

Results

Figure 1 shows the duration (in seconds) of any aggressive displays (left-hand y-axis) and the distance from the subject (right-hand y-axis) across trials (x-axis) for each decoy used (top to bottom panels) across baseline, treatment, and maintenance. An 'X' on the graph indicates the aggressive display occurred after the decoy turned and was exiting the area.

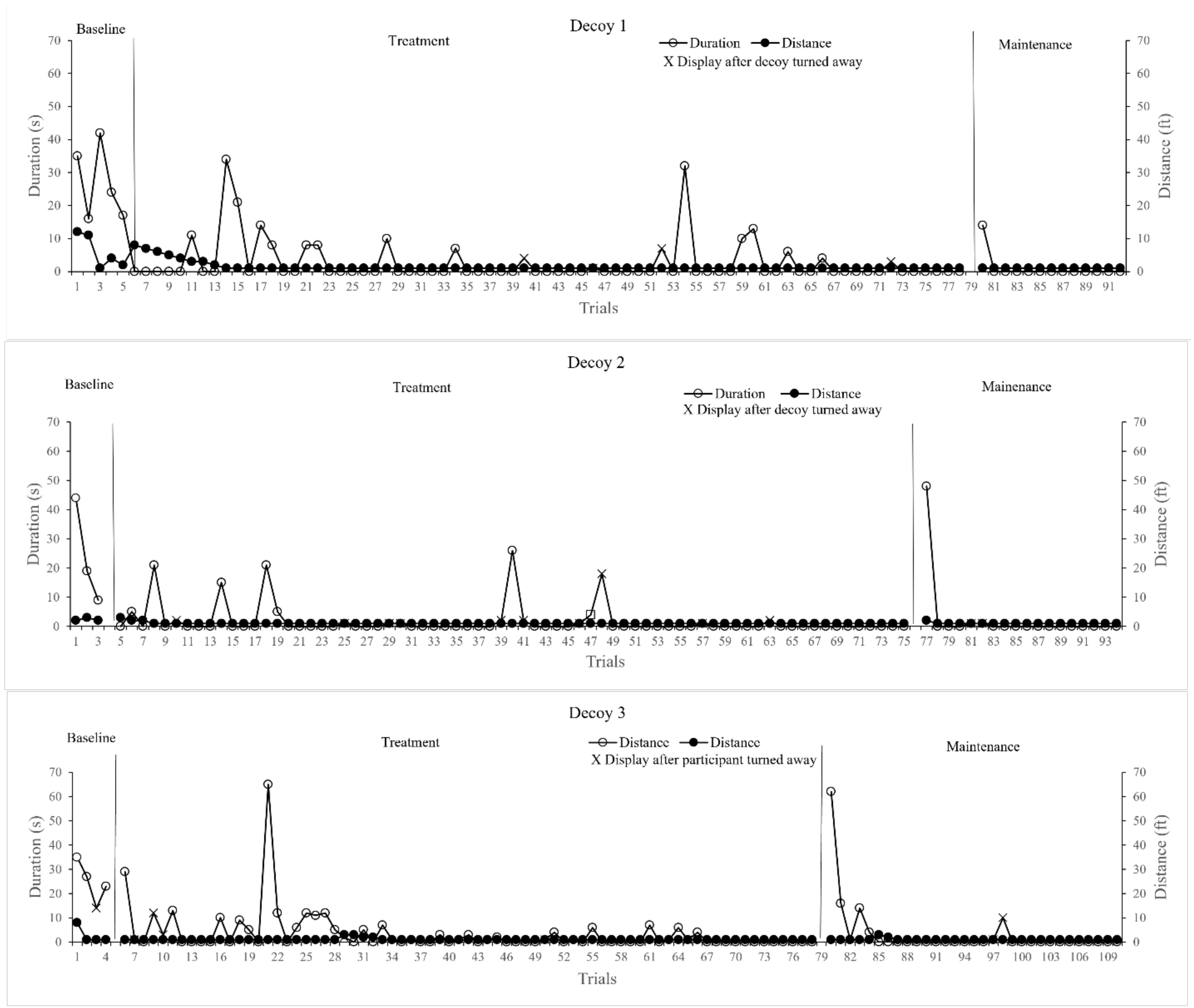

Figure 1. Duration and Distance of Aggressive Displays by a Hybrid Orangutan

Results for Decoy 1 (top panel of Figure 1) show that the distance from the subject ranged from one to twelve feet during baseline. The duration of aggressive displays ranged from 16 to 42 seconds during baseline. During the treatment phase for Decoy 1, the initial trial was at eight feet. This distance decreased by one foot each trial until reaching the criterion distance of one foot from the subject. Decoy 1 moved within one foot of the subject on trial 14, and the longest aggressive display (34 seconds) occurred during this trial. On the following trial, per preset criterion, the decoy went back to one foot and the aggressive display reoccurred and lasted 21 seconds. While aggressive displays did occur variably and ranged between 0 to 34 seconds, the decoy was able to remain at the one-foot marker for the remainder of the treatment phase (given the preset criteria of five consecutive aggressive displays before the decoy moved back two feet). The duration of the aggressive display systematically decreased across trials in the treatment phase with the exceptions of trial 54 (which included a 32 second display of aggression), trial 59 (10 seconds), and trial 60 (13 seconds). There were no notable changes in the environment during these trials. The subject met the criteria (one-foot distance from decoy with no aggressive displays for six consecutive trials) with Decoy 1 at trial 78. During the maintenance phase for Decoy 1, the subject engaged in aggressive displays on the first trial for a duration of 14 seconds at a one-foot distance from the decoy. The subject did not engage in any aggressive displays for the remainder of the phase. The subject had 12 consecutive trials at one foot with no aggressive displays.

During baseline for Decoy 2 (shown in the middle panel of Figure 1), the subject engaged in aggressive displays ranging in duration from nine to 44 seconds. The distance between the decoy and the subject ranged from two to three feet. During the treatment phase, the decoy started three feet away from the subject. In each subsequent trial, the decoy moved one foot closer to the subject until it reached one foot. The duration of aggressive displays by the subject during the treatment phase ranged from zero to 26 seconds. The longest display of aggressive behaviors was during trial 39. There were five instances of increased magnitude of aggression (e.g., duration) which occurred in trials seven (21 seconds), 13 (15 seconds), 17 (21 seconds), 39 (26 seconds), and 47 (18 seconds). For Decoy 2, the mastery criterion was increased from five consecutive trials at one foot with no aggression and accepting the candy from decoy on the sixth trial to 11 consecutive trials at one foot with no aggression and accepting candy on the twelfth trial. Between trials 30-34 there were no aggressive displays, and the subject took and ate the candy on trial 35. Given the new criterion for mastery, five more trials were required. The subject engaged in an aggressive display on trials 38 (two seconds), 39 (26 seconds), and 40 (two seconds). During trial 46 the aggressive display by the subject appeared to be in response to the other adult male orangutan (who was in the night house but in a different area during the trial due to the heat index outside). Following this four-second aggressive display, in the following trial (47) he aggressed for 18 seconds (the third longest display of this phase). In trials 48-55 there were no aggressive displays, and on trial 56 he had a one second display of aggression. In trials 57-61 there were no displays, and on trial 62 he had a two second display, and on trials 63-74 there were no displays of aggression. The subject met mastery criteria of 12 consecutive trials and taking and eating candy from decoy on trial 74.

During the maintenance phase for Decoy 2, the initial distance between the subject and decoy was two feet. This decreased to one foot in the following trial and the distance remained at one foot in the remaining maintenance trials. During the first trial of the maintenance phase for Decoy 2, the subject engaged in an aggressive display for a duration of 48 seconds. In the following trial, the subject engaged in alternative, acceptable behaviors. There were only two other trials during the maintenance phase for Decoy 2 in which the subject engaged in aggressive displays. Each of these trials had a duration of aggressive displays for one second.

For Decoy 3 (shown in the lower panel of Figure 1) the distance at which aggressive displays occurred during baseline ranged from one to eight feet. The duration of aggressive displays in baseline ranged from 14 to 35 seconds in duration. The treatment phase with Decoy 3 started at one foot. In trial 28 during treatment, the decoy was required to increase her distance to three feet from the subject due to five consecutive trials of aggressive displays. This was the first instance of having to increase the distance between the subject and any of the decoys. The subject engaged in an aggressive display in the first trial at three feet (trial 28) which meant that trial 29 would also be from three feet. During trial 29, the subject engaged in acceptable, alternative behaviors. In trial 30, the distance decreased to two feet. The subject engaged in aggressive displays. Therefore trial 31 was also from two feet. The subject engaged in acceptable, alternative behaviors in trial 31 so the distance decreased to one foot in trial 32. All remaining trials during the treatment phase were from one foot. The duration of aggressive displays in the treatment phase for Decoy 3 ranged from zero to 65 seconds. Trial 20 was the longest display of aggressive behavior (65 seconds) across any decoys. The subject met the criteria with Decoy 3 at trial 71 for the first time, and he met mastery criteria twice consecutively at trial 77. The aggressive displays in the maintenance phase with Decoy 3 had durations ranging from zero to 62 seconds. The distance between the subject and decoy during the maintenance phase started at one foot. Similarly, in the treatment phase with Decoy 3, the distance had to be increased between the subject and decoy during the maintenance phase (trial six) but decreased in each subsequent trial until one foot. The subject met mastery once at trial 13, but the subject engaged in aggressive displays in trials 18 (one second) and 19 (20 seconds). The subject did not engage in any other aggressive displays after trial 19 and reached the criteria twice consecutively at trial 31.

	Duration		Trials to Criterion	
Decoy	Treatment	Maintenance	Treatment	Maintenance
1	101 min	9 min	78	13
2	65 min	14 min	35 (74)*	18
3	80 min	23 min	71 (77)*	31

Table 1. Duration and Trials to Criterion for Treatment and Maintenance Phases for Decoys
Note: This also includes the number of trials it took the subject to reach criterion once in treatment (six consecutive trials) and twice in the maintenance phase (12 consecutive trials).
*For Decoys 2 and 3 an additional six trials of no aggressive displays and taking candy from the decoy were amended to the previous mastery criterion of six trials (for Decoy 1, see methods for details).

Table 1 shows the duration and trials to criterion for all three decoys during the treatment and maintenance phases. In the presence of all three decoys, the duration of time required to meet criteria from treatment to maintenance decreased. Specifically, 91% for Decoy 1 (from 101 minutes in treatment and nine minutes in maintenance), 78% for Decoy 2 (from 65 minutes during treatment to 14 minutes in maintenance), and 71% for Decoy 3 (from 80 minutes in treatment to 23 minutes in maintenance). The number of trials to reach criteria also decreased across decoys. For the initial mastery criteria (e.g., six consecutive trials in treatment), there was an 83% decrease for Decoy 1 (78 trials to 13 trials), 49% for Decoy 2 (35 trials to 18 trials), and 56% decrease for Decoy 3 (71 trials to 31 trials). For the secondary criteria (e.g., 12 consecutive trials), there was a 76% decrease for Decoy 2 (74 trials to 18 trials) and 60% decrease for Decoy 3 (77 trials to 31 trials).

Discussion

The subject displayed aggressive behaviors towards all three decoys during all baseline trials. During treatment, these aggressive displays systematically decreased in frequency, and, for the most part, in duration (with few notable exceptions such as trial 21 for Decoy 3). At the end of treatment, each decoy was able to approach and interact safely with the subject without any aggressive displays. These results required 78 trials or fewer for each decoy and the amount of time to reach the criterion during maintenance was markedly less than during treatment (see Table 1). For each of the decoys, the subject engaged in aggressive behavior during the first trial of the maintenance phase. After this first trial of maintenance for Decoys 1 and 2, and after the fifth trial for Decoy 3, the subject did not engage in any other aggressive displays (with the exception of two brief displays while the decoy walked away for Decoy 3). While the subject did re-engage in aggressive behavior during maintenance, the duration and number of trials needed to decrease do not look the same in frequency or duration as they did in the original treatment. Specifically, for Decoy 1, the subject engaged in one aggressive display for 14 seconds on the first trial of maintenance and then only engaged in alternative, acceptable behaviors for the remainder of the maintenance phase. For Decoy 2, the subject engaged in an initial display of aggressive behaviors for 48 seconds during the first trial of maintenance and had two bouts of one second displays in trials five and six after the decoy turned to walk away. For the remainder of maintenance for Decoy 2, the subject only engaged in alternative, acceptable behaviors. For Decoy 3, the subject engaged in aggressive displays during the first five trials (62 seconds, 16 seconds, one second, 14 seconds, four seconds) followed by 12 trials of only alternative, acceptable behaviors. During trial 18, the subject engaged in a one-second aggressive display followed by a 10-second display during trial 19. The subject then only engaged in alternative, acceptable behaviors for the remainder of the phase. This suggests that the subject was able to maintain the alternative, acceptable behaviors over time, and while a “reminder” trial was necessary during maintenance, the alternative, acceptable behaviors returned more quickly than during training.

The duration of the intervention and maintenance phases and the number of trials to criterion decreased between Decoys 1 and 2 (see Table 1), suggesting that acceptable behaviors may have generalized across decoys. It did take the subject a longer duration and more trials to criterion for Decoy 3. This may be due to differences in the aversiveness of each of these decoys or the familiarity with each of the decoys (e.g., the subject had interacted with Decoys 1 and 2 since 2009 whereas he had only known Decoy 3 for approximately one month). The increased mastery criterion for Decoys 2 and 3 (from six consecutive trials to 12) provided some interesting insights into how mastery criteria was set, and how behavior may change in follow-up trials. In the presence of Decoy 2, the subject met the initial criteria (e.g., six consecutive trials) at trials 35 and 53 but did not meet the increased mastery criterion (e.g., 12 consecutive trials) until trial 74. If the increased mastery criterion had not been implemented, trials would have ended at trial 35. Though the subject engaged in mostly small bouts of aggression during this time (between 1-26 seconds in trials with aggression and many where no aggression occurred at all), the subject was exhibiting behaviors that had resulted in removal of the decoy in the past. This suggests that an increased mastery criteria was more appropriate in that the subject had more time for previously negatively reinforced aggressive behaviors to be extinguished, and more appropriate behaviors to be reinforced. Alternatively, regarding the aggressive displays during maintenance, the subject engaged in aggression for a shorter duration towards Decoy 1 than in the initial trial than what was observed for Decoy 2 or 3. This may suggest that the mastery criteria was appropriate, but there are differences in reactions to the individual decoys. Determining what the appropriate mastery criteria is may be both human and animal specific, and it may depend on the stimulus being used.

It is important to note that regardless of mastery shown during training, the behavior did reappear during the first trial of maintenance, albeit, lower in duration. This suggests that while this procedure is effective at reducing the frequency and duration of aggressive behaviors, ensuring that the replacement behaviors maintain over time may require additional maintenance and, of course, ensure that individuals caring for the subject are aware of the appropriate contingencies to implement if aggressive behaviors occur (e.g., remaining in proximity until more appropriate behaviors occur). This also includes determining the positive and/or negative reinforcing contingencies to put in place. That is, these decoys should also be working to enhance their reinforcing properties following the decrease in aggressive behaviors. Future research may look at more effective ways of identifying appropriate mastery criteria and how these criteria may alter the immediate and long-term effects of this procedure.

Like any applied research that occurs in a natural environment, there were some variables that could not be kept consistent in the environment. For example, due to excessive heat, other orangutans had access to a parallel holding area during both treatment and maintenance sessions for Decoys 2 and 3. While this change may have been beneficial for potential generalization of appropriate behaviors in different environments, it may have contributed to the bouts of aggression seen later in the treatment phases. While it may be valuable to implement the new negative reinforcement contingency for aggressive behavior in a controlled environment, when and where to implement more distractions may depend on the success of the subject and the specific environments where these behaviors occur. While it was not within the scope of this study to explore how to best introduce extraneous distractors or changes in the environment, future research may illuminate best practices, or the variables to consider when deciding how to introduce noise to the environment.

Overall, the subject in this study engaged in aggression towards specific individuals. This aggression was adversely affecting the subject and those who care for him. Following the CAT procedure, aggressive displays decreased, and the subject began to engage in more appropriate behaviors in the presence of, and towards, each decoy. This continued until the subject was able to receive a preferred edible from each decoy and consume it in their presence. It is noteworthy that by the end of the treatment, and continued into maintenance, the subject was willing and able to take food from each decoy and consume it in their presence. This suggests a level of comfort and calmness typically far removed from aggressive displays and fearful behavior (which prior research has referenced as the “switchover point”).

Overall, the CAT procedure is a valuable procedure that can reduce problem behaviors that are deleterious and dangerous for both animals and those who care for them. This research demonstrates its effectiveness in a zoo setting with an exotic species. Continuing to expand the proven efficacy of the CAT procedure in a variety of species, settings, and behaviors is valuable. Additional research should also focus on developing a better understanding of the details of the procedure. These include (but are not limited to) setting mastery criteria, the effects of introducing variability into the initial procedure, and the “switchover point”. A better understanding of these variables would yield valuable insights into the CAT procedure from an applied perspective, but also potentially help illuminate the more basic principles of the differences and similarities underlying positive and negative reinforcement.

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