USING AUTOMATED ENRICHMENT TO IMPROVE THE HUMAN ANIMAL BOND

An Undergraduate Research Scholars Thesis

by

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ABSTRACT

Using Automated Enrichment to Improve the Human Animal Bond

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Stress has been shown to have a negative effect on every stage of an animal's life cycle, from birth rates to weaning (Clincy, Sheriff & Zanette, 2013). Early socialization through habituation has been shown to decrease an animal's stress to certain stimuli (Ramirez, 1999). For prey animals like the birds we house in the Schubot Exotic Bird Health Center at Texas A&M University, a new person coming and interacting with them could be a stressor alone. Because these birds are in captivity, they will come into contact with people that are performing health checks on them. In order to attempt to habituate the birds to a new person, a tablet was used to associate a video of the visitor to a primary reinforcer of an alternate commercial diet. This experiment used the concepts of behaviorism and positive reinforcement to train the birds to change their response of fear to the unknown person to a more comfortable state. The time it took to approach the visitor before and after the study was analyzed by counting stress-related behaviors and time the visitor had to hold the treat for a health check for each bird. A total of twelve birds participated in this experiment for three weeks. All the birds were housed in their regular housing in the aviary in compatible male-female pairs. The tablet could not be destroyed by the birds, did not interfere with the bird's normal feeding schedule and would give treat crumbs when the video of the familiarized person appeared on the screen at programmed

scheduled times. The birds overall showed less stress and were more social to both volunteers. The magnitude of change in stress was greater for the familiarized person than it was for the unfamiliar person. The colony as a whole also was faster and more willing to complete the health check. After providing automated enrichment, the birds, not only displayed the benefits of decreased stress, but the visitor himself also showed clear satisfaction with the improvement of the human-animal bond.

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DEDICATION

I would like to dedicate this paper to the current and aspiring veterinarians, researchers and animal caretakers. This research was conducted to help improve the human-animal bond and improve everyone's health overall. The work done by these people is difficult and we can never show enough gratitude to these people. I dedicate this work to the future lab groups that come after me. May future generations continue this research in order to keep more animals and people happy and healthy.

ACKNOWLEDGEMENTS

Thank you to Donald Brightsmith for being my PI and approving this project. Thank you to my fellow undergraduate researchers on my team from this year and years passed. This project was successful due to the effort of many and I hope that the effort of my research team this year will also help the future research teams under Dr. Brightsmith. And a special thank you to Dr. Jane Packard, who kindly helped me after her retirement with her outstanding knowledge in the field. I would also like to thank all the people outside my research team that volunteered to help push this project forward. I would like to express my deepest gratitude especially to my graduate student mentor Constance Woodman. Her time, dedication, focus, patience and knowledge were integral to this experiment and to my growth as a researcher. Her willingness and understanding are what kept me going when research and life were difficult. She endured every aspect of this project with me, from participating in the methodology of the experiment, to late nights crunching numbers. Finally, I would like to thank the Quaker Parakeets I researched with for taking part in my experiment and always putting a smile on my face.

CHAPTER I

INTRODUCTION

Behavior modification applies to any species with the ability to learn through a schedule of reinforcement (Skinner, 1990). Animals and humans alike, are exposed to different stimuli throughout their lifetimes that have the potential to cause stress. These stimuli could be traumatic events that affect the future behavior, cognitive ability, and genetics of an animal (Clincy, Sheriff & Zanette, 2013). Because animals' future responses are influenced by learning, each exposure to stress may change the animal's future behavior. Exposure to a previously traumatic experience can cause stress to rise and affect that animal's physical, mental and social capacity (Clincy, Sheriff & Zanette, 2013).

The model animals for this experiment are captive Quaker Parakeets. These captive birds at A&M are fed ad libum, which eliminates enrichment from foraging. It has been known since 1963 that rats prefer to work for their food even when identical food is freely available (Jensen, 1963). The preference to work for food is called "contrafreeloading," and has been shown across clades, including pigeons and primates (Reinhardt, 1994; Neuringer, 1969; Singh, 1970).

This can lead to negative or destructive behavior. For birds, this can provoke reactions such as biting, screaming, and feather- plucking or other forms of self- mutilation (Hoek, 1998). Parrots also tend to be neophobic, which is a problem when they are being introduced to new stimuli in captivity. Having a stimulus that is novel could alter a bird's behavior so much that they may abstain from eating (Mettke-Hofmann, Han Winkler & Bernd Leisler, 2002). In this experiment,

presenting a new person may disrupt food intake of the birds and could cause sustained psychological stress that effects the demographics of a prey animal more that direct killing itself (Clincy, Sheriff & Zanette, 2013).

Stress changes the body physiologically and animals have different ways of coping with this stress behaviorally (Sorge et al, 2014; Costa et al, 2016). These signs of stress change from species to species and from individual animal to individual animal (Sorge et al, 2014). Even though different animals show different or no external behavioral signs of stress, scientists can measure the internal physiological effects of stress on animals (Clincy, Sheriff & Zanette, 2013; Costa et al, 2016). Birds that are prone to stress and anxiety will exhibit observable behaviors such as picking at their own feathers in the form of Feather Damaging Disorder and exhibit internally increased levels of corticosterone metabolite, which can be measured in excreted feces (Costa et al, 2016). On the other hand, laboratory rats will reduce visible behaviors such as visible responses to pain, so stress can create or inhibit behavior.(Sorge et al, 2014). Even though both of these animals are prey animals, they have very different behavioral responses to stress. The differences between species-specific responses are the reasons why it is important to research the different signs of stress in each species or be able to take an internal measurement of stress without causing stress to the animal in the process. One particular experiment made sure to take measurements without the presence of the human experimenters, because a bird's primary sense is their vision, therefore the visual stimulus of the people caused more stress in the experimental birds than a system that took measurements without the presence of people (Le Maho et al, 1992)

Certain stimuli will cause stress in certain animals and will cause no response in other animals. Predator-induced stress can induce sustained psychological stress (Clincy, Sheriff & Zanette, 2013). Natural selection has chosen prey animals that can avoid predators, thrive to reproduce and pass on their genes. Although genetics is a major factor on the behavior of an animal, the environment affects the reaction an animal will have also. The environment can affect what genes will be expressed. Animals with the cognitive ability to learn can learn to associate a positive or negative reaction to a previously neutral stimulus based off the consequences of reacting to that stimulus. Therefore one can use positive reinforcement training to habituate an animal to a situation (Ramirez, 1999; Rank, Zaparanick & Gentry, 2009).

Constant stress can have a negative impact on multiple aspects of an animal's life (Clincy, Sheriff & Zanette, 2013). Stress and fear alter the brain and the neural connections that are made. When an animal experiences an event that is traumatic, the plasticity of the brain allows the formation of more neural connections to the amygdala to cause the animal to learn from the traumatic event and remember it (Johansen, 2011) When an animal cannot escape the stressor, whether it is a physical or psychological, the animal can go into a state of learned helplessness, which is similar to human depression (Batsching, Wolf & Heisenberg, 2016) This stress can be transferred to animal caretakers in the form of compassion fatigue (Sabin-Farrell & Graham, 2003; Rank, Zaparanick & Gentry, 2009). Learned helplessness is only one of the outcomes of too much stress. Some animals may choose to instead avoid and escape the stressful situation instead (Batsching, Wolf & Heisenberg, 2016). How the animal reacts depends on the resilience of the animal. Stress mainly affects animals and people mentally, but mental health is related to physical health. Furthermore, the effect of fear on the emotional part of the brain affects the

sociability of an animal. An animal that is under chronic stress will be socially withdrawn and lethargic (Batsching, Wolf & Heisenberg, 2016).

The stress the birds have when a person that handles them could cause compassion fatigue in the caretaker. Animal caretakers derive their identity, work satisfaction, philosophical meaning, and enjoyment from interaction and caring for animals. Animal caretakers range from laboratory personnel, to zoo keepers, farmers, animal assisted therapists, conservation workers, and veterinary medical workers in addition to pet keepers. Animal caretakers take their animals' stress to heart and can feel overwhelmed by their work (Rank, Zaparanick & Gentry, 2009). This stress the animals exhibit could lead to compassion fatigue in the caretaker (Sabin-Farrell & Graham, 2003). Compassion fatigue can lead to depression, anxiety, and suicide, suicide risk being greatly increased in veterinarians (Rank, Zaparanick & Gentry, 2009). This experiment used a video based enrichment system to create a bond between animals and a person, by creating trust and comfort in animals.

CHAPTER II

METHODS

Background on the Bird Colony

Thirty Quaker parakeets were trained to come to a lab worker and take a treat, allowing for visual inspection for nasal, oral or vent discharge, issues with bottoms of feet, nail length, breathing, and posture. This training also allows for birds to voluntarily transfer to carriers (treat offered in back of carrier), be moved within the enclosure, recalled after indoor free flying for student demonstrations, or recalled if they escape from an enclosure due to researcher error. The birds all previously came to a trusted worker in less than a minute for a treat. The birds are wary or fearful of new people, but new students join the lab each semester. This can cause stress while the birds get to know the new worker.

Bird Assignment

The thirty birds in this colony had all been previously trained and socialized. Birds that were chosen for this experiment were of different levels of activity, but each had performed the desired behavior on cue several times before. The cages that were chosen for treatment were spaced out evenly throughout the colony. Birds were then divided into treatment and control groups of six birds each based on balancing the initial stress behavioral responses to each of the simulated new workers across treatment groups.

Study Design

Association of a person and the desired primary reinforcer was established through the means of a tablet provided to six previously socialized Quaker parrots (Myiopsitta monachus). The birds

were kept in groups of two in their normal enclosures at the aviary for the duration of this experiment. Birds were fed *ab libum* on a commercial pelleted diet, and had access to this diet at all times and the treatment did not alter the birds' nutritional balance as the reinforcer was a nutritionally complete diet. A tablet mounted inside the cage on the door and the food dispenser, attach on the outside of the cage on the door, dispensed treats into their regular food bowls. Birds at the beginning of the experiment were visited by two new people on separate occasions. The visitors were of similar identities and were instructed to act neutral. Each visitor held up the treat at chest height while a trusted worker stood behind and video recorded the interaction. If the birds did not take the treat, the strangers remained at the cage for up to 3 minutes. If both birds in the enclosure performed the health check and took the treat, then visitor could move on to the next cage. Both visitors went to the cages in the same order. The first visit occurred months before the experiment was conducted. Then the study was conducted for three weeks. The tablet was programmed to play a silent one-minute video of the familiarized volunteer intermittently from the periods of 9 AM to 11 AM and 4 PM to 6 PM. Every three days the video was brightened by 25% to slowly habituate the birds to the video. The last twelve days, the video was played at 100% brightness. At the end of the experiment the birds were then visited by the familiarized and unfamiliar visitor on different days the same way previously described in the initial visit.

Enrichment System Design

The system is composed of a mounted tablet computer, a circuit, and a corkscrew feeder. The tablet was housed in a protective case so the birds would not have access to chew on the wires. The corkscrew feeder dispensed treat crumbs into a plastic funnel that emptied into the birds' normal feeding dish. The plastic funnel was made out of a soft plastic material that was safe for

the birds to chew on. The corkscrew feeder was 3-D printed and washed before it was mounted. The tablet was programmed to play a silent one-minute video of the experimental volunteer intermittently from the periods of 9am-11am and 4pm-6pm. The treats would dispense, in the middle of the video, into the regular food bowl. The tablet would be taken down and turned off in order to charge them at 11 AM and 6 PM every day and the feeder was refilled each time for the duration of the three weeks of the experiment. The treat crumbs were automatically dispensed in the middle of the one minute video. The video at the beginning of the experiment was set to 25% brightness and this gradually increased to 100% brightness to slowly habituate the birds to the video. Below is a link of the birds interacting with the system in real time: https://drive.google.com/file/d/0B1OrKp_03z9eMVpManFzX3k2aXM/view?usp=sharing

Scoring Methodology

The video recorded from the walkthroughs was split to have individual cage videos with Windows Movie Maker and each clip had a watermark that indicated the trial, person, and cage number. The high-stress and low-stress behaviors used to score the clips were defined and clearly visible. All stress behaviors were validated as high-intensity and low-intensity behaviors for Quaker Parakeets through consultation with members of the Schubot Lab. These definitions were used to construct a quantitative survey of the Quaker Parakeets natural behaviors in an ethogram. The definitions were made so that a blind scorer could validate the behaviors of each individual bird. Two measures of behavior were recorded. These measures quantified if the husbandry task success was impacted by the digital enrichment, and if the birds' comfort was impacted by the digital enrichment. First, did the birds come to the front of the cage and or take the treat, allowing for a health check? Second, did the birds display stress behavior during the

task? These questions were asked to analyze the effectiveness of the digital enrichment system. The stress behaviors were tallied and the definitions for these behaviors are stated below:

Low-Intensity Behaviors

Scratching - bird itches themselves comfortably

Stretching -bird outstretches wing

Preening - bird grooms themselves

Napping - eyes close or partially close for an extended period of time

Take Food - Bird takes food out of stranger's hand

Approaching - Bird attempts to get closer to the stranger. One foot on the front of the cage

Health Check - Birds can be inspected at the front of the cage for at least 3 seconds or takes the treat. This is a yes or no behavior.

High-Intensity Behaviors

Attempt to Steal Food - bird steals food from their partner

Aggressive Behavior in Birds - bird is aggressive toward another bird by attempting to lunge and bite

Alarm Cal l- deep growling repetitive call (Martella & Bucher, 1990) each call was counted

Flight Call - faster, louder eee eee eee sound (Martella & Bucher, 1990) each call was counted

Poop and Fly Away - nervously defecates in any position and looks for escape away from stranger

Retreat- fly away from stranger toward the back of the cage (was not counted if food was in the bird's foot)

Biting -adequate pressure was emitted from the bird to make the visitor withdraw their hand

Beak Wiping- rubbing beak against the perch

Wing Flicking- pushing wings back and making the bird bigger, each flick was counted

Hovering- Rapid wing flapping causing floating in the center of the cage. This is a contained escape flight

Statistical Methodology

The alpha value set for this experiment was 0.05. This value is a standard value, but the alpha value is usually 0.1 in behaviorism literature. The time the visitors had to hold the treat for each bird and the number of high-intensity behaviors was recorded for each individual bird during the walkthrough before the three-week experiment and during the walkthrough after the experiment. The Wilcoxon Signed Rank t-test was used on a total of fourteen null and alternative hypothesis pairs to analyze the results of this experiment. The Welch and Students's t-test were compared to each other to see if the birds had a similar response to the familiarized and the unfamiliar person.

CHAPTER III

RESULTS

Case Study

All the birds in the study had their behaviors scored individually. The birds in the colony as a whole became more socialized to both people before and after treatment (Wilcoxon Sign Rank: V=162.5, Nt1=24, Nt2=24, p=0.0331). The female birds, in general, are more cautious, which causes them to be more stressed and slower than their male counterparts. The female bird in cage 77 showed marked improvement after digital enrichment treatment. During the first walkthrough the female exhibited 49 high-intensity behaviors and the familiarized volunteer had to hold the treat up the cage bars for the full 180 seconds (Table 3.1). In the second walkthrough, the female completed the health check in 13 seconds (before her male counterpart) and exhibited 0 high-intensity behaviors to the familiarized volunteer (Table 3.2). At the end of the experiment the familiarized volunteer was visibly happier and voluntarily vocalized that the birds liked him better now. The difference can be easily observed in the video links below: Familiarized Walkthrough 1:

https://drive.google.com/file/d/0B1OrKp_03z9edWRBVUVVVFllVlU/view?usp=sharing

Familiarized Walkthrough 2:

https://drive.google.com/file/d/0B1OrKp_03z9eYjlYcV9HdkZGdTA/view?usp=sharing

Table 3.1- Ethogram for Cage 77 Female Bird Walkthrough 1 with the Familiarized Person

Low Stress Behaviors	Female # of behav	Time to perform behavior (sec)			
Scratching	0	0		Total	1
Stretching	0	0			
Preening	0	0			
Napping	0	0			
Take Food	0	0			
Approaching	1	17			
Health Check (Y or N)	Y	20			
High Stress Behaviors					
Attempt to Steal Food	0	0		Total	49
Aggressive Behavior	3	73,75,78			
Alarm Call	36	2,5,31,33,34,35,37,40,41,42,43,46,47,58,61,68,70,73,95,109, 111,116,123,124,125,130,132,134,136,147,149,156,159, 161, 162, 170			
Poop and Fly Away	0	0			
Retreat	2	21, 64,			
Flight Call	5	53, 54, 55, 175,176,			
Biting	0	0			
Beak Wiping	0	0			
Wing Flicking	3	123, 124, 130			
Hovering	0	0			

Table 3.2- Ethogram for Cage 77 Female Bird Walkthrough 2 with the Familiarized Person

Low Stress Behaviors	Female Trial 1 # Behaviors	Time to perform behavior (sec)			
Scratching	0	0		Total	2
Stretching	0	0			
Preening	0	0			
Napping	0	0			
Take Food	1	13			
Approaching	1	2			
Health Check (Y or N)	Y	5			
High Stress Behaviors					
Attempt to Steal Food	0	0		Total	0
Aggressive Behavior	0	0			
Alarm Call	0	0			
Poop and Fly Away	0	0			
Retreat	0	0			
Flight Call	0	0			
Biting	0	0			
Beak Wiping	0	0			
Wing Flicking	0	0			
Hovering	0	0			

Statistical Analysis

efore the experiment, the birds responded similarly to both the familiarized person and the unfamiliar person, so the people were good for comparison (Students's and Welch's T-Test: Nt1=24, Nt2=24, p=0.75). Using a Students's and Welch's T-test, a p-value of 0.75 showed the similarity of stress responses per bird for the unfamiliar and familiarized person. After the treatment, (which was half the birds watching the other half of the birds receive treats from the virtual familiarized person for 3 weeks) the birds responded similarly to the unfamiliar person at time one and the unfamiliar person at time two (Wilcoxon Sign-Rank test, p = 0.414). The birds responded dissimilarly to the familiarized person between time one and time two, with a 75% decrease in stress-associated behaviors (185 stress behaviors in time one and 47 stress behaviors in time two.) Using a Wilcoxon Sign-Rank test, a p-value of 0.036 showed the scores were significantly different. From the perspective of the familiarized person, he had an increase of successful health checks, and reduced his time at "work" by 32% and enjoyed his time there. We interpret these statistics to mean that the entire group learned to "trust" the familiarized person due to the treatment, but the group did not learn to trust the unfamiliar person.

Table 3.3- High Intensity Behaviors Evaluated with Wilcox Sign Rank Test

	Time 1	Time 2	Difference	N	P-value
All birds presented with familiarized person	185	47	138	12	0.0364*
Only treatment group responds to familiarized	81	5	76	6	0.0579**
Only contorl group responds to familiarized	104	42	62	6	0.498
All birds presented with unfamiliar person	154	126	28	12	0.414
Only treatment group responds to unfamiliar	47	15	32	6	0.0899
Only control group responds to unfamiliar	117	111	6	6	1
All birds responses to the familiarized and unfamilar person	339	173	166	24	0.0331*

Table 3.4- Total Time in seconds for Volunteer to Hold Treat Evaluated with Wilcox Sign

	Time 1	Time 2	Difference	N	P-value
Familiarized to whole group	1232	836	396	12	0.0519**
Familarized to treatment group	598	427	171	6	0.4227
Familariized to control grouip	634	409	225	6	0.1003
Unfamiliar to whole group	1141	819	322	12	0.0591**
Unfamilar to treatment group	422	394	28	6	0.371
Unfamilar to control group	719	425	294	6	0.181
All birds to the familarized and unfamiliar	2373	1655	836	24	0.005*

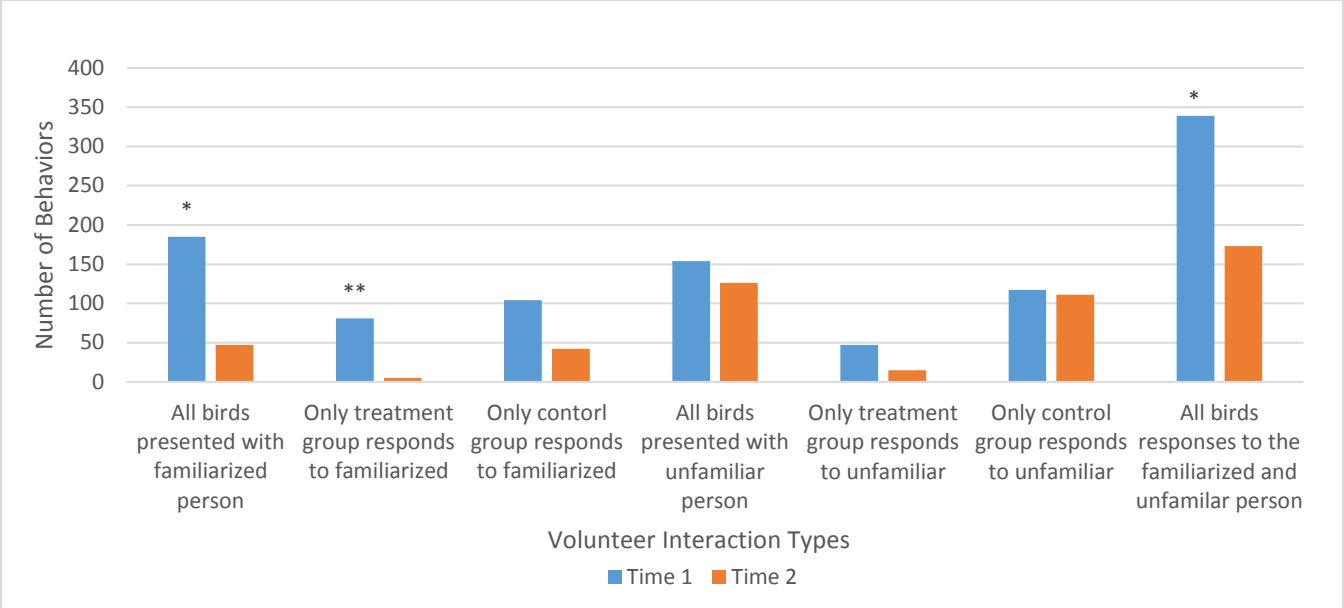

Figure 3.1- High Intensity Behaviors Evaluated with Wilcox Sign Rank Test.
*-These results are significant. All the birds behaviors changed towards both people, but the magnitude of change was greater for the familiarized person.
**-This result was slightly significant. The change is behavior for the treatment bird was the most significant toward the familiarized person after treatment.

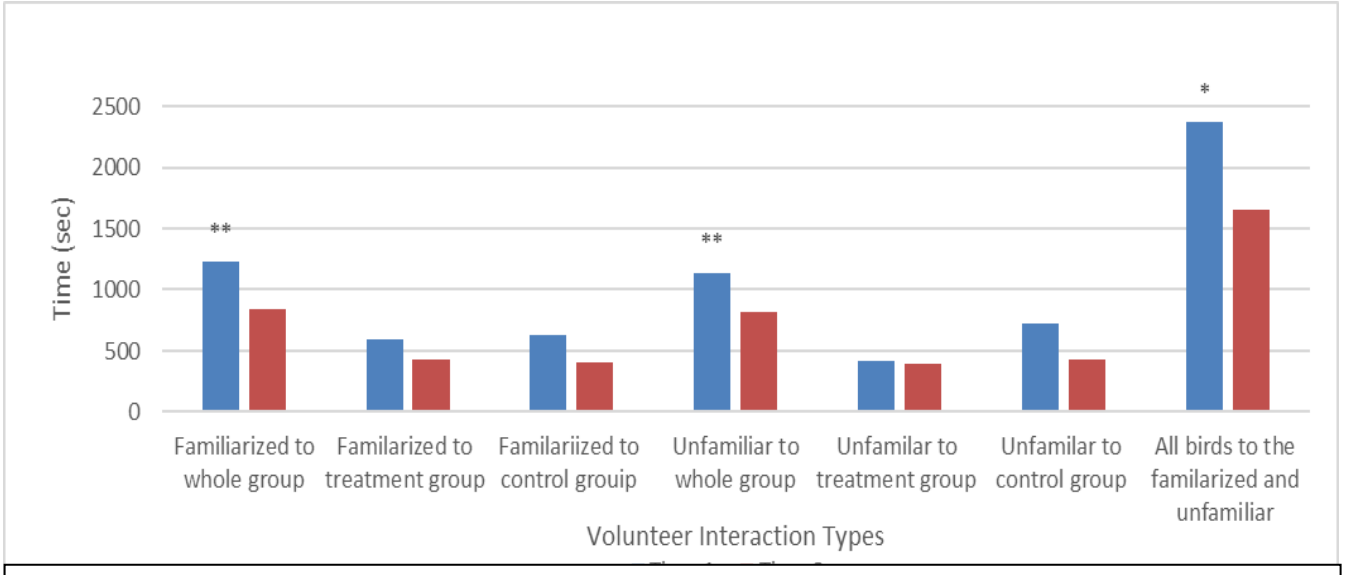

Figure 3.2- Total Time for Volunteer to Hold Treat Evaluated with Wilcox Sign Rank Test
*- This result was significant. The whole colony in general became faster and more responsive to health checks
**- These results were slightly significant and indicate the both the familiarized and unfamiliar person improved with performing health checks.

Colony Observation

The interaction with the Enrichment System was not consistent. The treats would be dispensed into the bird's regular food bowl whenever the video played. The birds were not consistent with their interaction with the tablet. Even though all the birds were observed reacting to the tablet and getting the treat in real time, they did not do that consistently. Often times the video would play and the birds would just watch the treats be dispensed into their normal food bowl. The control cages were in close proximity to the treatment cages so the control birds were also getting positively associated to the video through simple observation.

Figure 3.3- Social Group Interaction with the Enrichment System. The birds gather around to watch the tablet screen on the treatment cage.

CHAPTER IV

DISCUSSION

Results Analysis

All the birds in the treatment group had been recorded interacting with the enrichment system in real time. The statistical analysis shows (Table 3.1) showed an overall socialization of the colony through the decrease of high-stress behaviors overall (Wilcoxon Sign Rank: V=162.5, Nt1=24, Nt2=24, p=0.0331). The magnitude of change of social behavior was greater toward the familiarized person than the unfamiliar person (Wilcoxon Sign Rank: V=15, Nt1=6, Nt2=6, p=0.058). The decrease of high-intensity behavior was 18% for the unfamiliar person and a decrease of 75% in the familiarized person for the whole colony after treatment. The whole colony behavior changed more so to the familiarized person (V=26, Nt1=12, Nt2=12, p=0.0364) possibly because all the birds were able to see the Enrichment System. Birds have also been shown to recognize familiar faces off of tablets before (Stephan, Wilkinson & Huber, 2012), so visual enforcement alone is enough to positive associate a stimulus to a primary reinforcer.

Time for the birds to perform a health check by receiving a treat was the other measurement for this experiment. There was overall a 30% reduction for the volunteers to hold the treat for a health check, with the familiarized person specifically having a 32% reduction in time and an increase in 2 successful health checks. The magnitude of these results is not as great as the decrease in high-intensity behaviors. This may be due to multiple factors. This might be because the birds were rewarded by the enrichment system even if they just sat there and watched. Also, there may have been little motivation to actually perform the health check because the birds'

regular food bowls were not controlled by the researcher and were always kept full. If the volunteer could have waited for an infinite amount of time, the change for time of approach could have been better recorded. The 180-second limit may have been too stringent for some of the birds, but this is a realistic time frame for a worker attempting to perform a health check and not stress the birds. Food motivation has been noted as the best primary reinforcer (Cloutier & Packard, 2014). Since the birds were possibly not hungry they also may not have been motivated to obtain the treat quickly. Overall experiment improved the birds' performance and did not make any of the birds significantly slower to perform the health check.

Statistical Errors

The Wilcoxon Sign Rank Test is a good test to utilize for small samples that cannot be normalized. The data used in this test had zero and ties errors. These errors make the p-value more conservative and it is possible that the some of the data was considered not significant when it actually was.

Significance of the Research

When a volunteer was first shown to the animals, the animals showed clear stress (alarm calls, attacking their cage objects) and the volunteer seemed a little disheartened. The experiment used the concept of positive reinforcement to train the birds to like the volunteer by showing a video of the man while the system dispensed treats. The birds could voluntarily approach the video screen to get treats from their bowl. After just three weeks of digital enrichment training, for less than half an hour a day, the volunteer was brought back in, to which the birds were on average calmer and interested in the man. After the second walkthrough the volunteer was visibly happier and grinned as he told me that the birds liked him better than the first trial.

This project scope could be extended to the home and biomedical health work. Adopted animals could more easily transition. In the veterinary field, animals could be trained to like their doctor. This would improve mental health and bond of both humans and animals alike. By training research animals to trust technicians, medical research data would be less likely to have biases caused by stress and discomfort. Through this training animals voluntarily become participants in their own health. This experiment also only utilized three tablets to train a whole colony. People do not have the time or resources to give the constant enrichment these animals need. Automated enrichment is a cost-effective way to train a colony and increase welfare for animals and the people who work with them.

Further Research

This experiment showed the most significance in relation to the whole colony and the familiarized person. This is most likely due to the fact that the control birds were able to watch to treatment bird get treated when they were getting positively associated to the familiarized person. A future study should also have an isolated group that cannot see the system to be the control group. Also, the birds in this experiment had already been previously trained. In order to keep working to improve the human-animal bond, it would be beneficial to see the effects of this experiment on birds who have had no previous training. Other considerations when possibly altering or replicating this experiment would be to have a constant recording of the birds' interaction with the system, programming this program to only dispense treats when the birds run up during the video, having more birds in the experiment to increase the n-value and possibly feeding the birds less to increase the motivation to do the desired task. Because the concepts of

behaviorism work effectively across multiple species, this experiment could be altered to train different breeds of birds or even different species (Skinner, 1990).

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