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A Look into the Activity Budgets of Captive Cotton-Top Tamarins (S. oedipus)

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A Look into the Activity Budgets of Captive Cotton-Top Tamarins *(S. oedipus)*

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ABSTRACT: Cotton-top tamarins *(Saguinus oedipus)* are a species of New World Monkey that are small in size. They live in groups that typically contain family members, including a breeding pair and their offspring. Seven related individuals were observed for this study, which was designed to ensure and evaluate the activity budgets of each tamarin. The aim of the study was to determine whether the older tamarins possessed different activity levels than the younger offspring. Each cotton-top tamarin was observed for an hour per week over a ten-week period. Each activity—playing with other tamarins, active in general, eating, grooming or being groomed, and other activities such as observing and resting—was timed and then added up to give a total time budget for each category. Predator versus non-predator mobbing calls were also observed and recorded during this study. It was concluded that there was a difference in the activity of the youngest tamarins versus the oldest tamarin. The oldest tamarin, Logan, had the lowest total time of 45 minutes for activity and play compared to 119 total time for Hippo, one of the offspring from the most recent birth. The finding that there was a difference in activity levels between the older and younger tamarins is important in aiding other researchers better understand the behaviors of captive cotton-top tamarins.

KEYWORDS: cotton-top tamarins; activity; social; alarm calls; captivity

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INTRODUCTION

Cotton-top tamarins *(Saguinus oedipus)* are small-bodied primates that have long, white hair on their heads and are bare-faced. Both the females and males have the same average height of 23.2 centimeters and weigh about 565.7 grams indicating that they are not sexually dimorphic. They are very agile and can maneuver through branches by either bounding, galloping, or running. They use their tails, which are about 25 centimeters in length, for balancing and moving through trees. *S. oedipus* are classified as a critically endangered primate species that resides specifically in northwestern Colombia (Savage, 2016). The main anthropogenic threats to these New World Monkeys are deforestation, illegal trade, and global climate change (Cawthon Lang, 2005). In addition, the close proximity of one of the top animal export centers in Colombia makes cotton-top tamarins easily accessible to be traded for human use as pets or for biomedical science (Neyman, 1979).

Females reach sexual maturity at about 15 to 18 months of age and will not exhibit normal ovulation. The female in the monogamous breeding pair represses the other females in the group from becoming reproductively active through behavioral and chemical restriction of sexual behavior (Cawthon Lang, 2005). In captivity, only one female copulates with a male. In the wild, for an offspring to reproduce it must leave the "family" and migrate into a neighboring group in order to find a mate. Both sexes may leave the natal group, meaning there is no bias between male or female wanting to mate with a member from a neighboring group. Mating male and female cotton-top tamarins are both dominant over the younger offspring of the group, but the breeding female is even more so. (Cawthon Lang, 2005). The female in particular will become aggressive towards her daughters, especially when food and territory are involved. A popular behavior amongst Callitrichids, which includes marmosets and tamarins, is cooperative rearing in which older offspring of the mating pair help care for and raise their siblings. This behavior is also seen in some avian species (Neyman, 1979).

Cotton-top tamarins participate in allogrooming, which is a form of social grooming between members of the same social structure. This behavior is used to establish and maintain bonds. For example, they may utilize grooming to encourage cooperation, to repay for a previous favor, or to reduce tension. This behavior is repeated frequently and is considered a form of reciprocal altruism (Trivers, 1971). The majority of such grooming occurs between the breeding male and female, but the other members of the group may also groom one another (Cawthon Lang, 2005). This was one of the behaviors observed in this study.

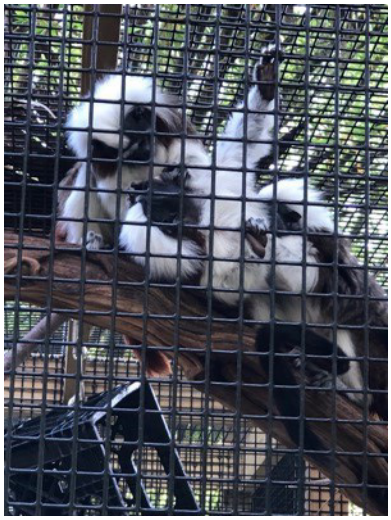

Figure 1. A photograph of Gidget and her offspring performing an allogrooming behavior.

Cotton-top tamarins eat a variety of fruits, leaves, and insects. Specifically the zookeeper at the Central Florida Zoo provides different types of food, including hard boiled eggs, insects, fruits, and vegetables. The tamarins are also given a callitrichid gel as a source of food. The zookeeper described it as a food source similar to how dogs are given wet dog food. It contains vitamin C, vitamin E, and other minerals according to the Mazuri Exotic Animal Nutrition website (mazuri.com), and it can be fed in combination with other foods such as fruits and vegetables. The amount given to the tamarins are based on their age, body size, and reproductive status. Food sharing is a form of kin altruism; it is strictly performed by related members. The only time they will share their food with unrelated individuals is due to a mutualistic relationship or because of reciprocal altruism (Hauser, 2003). It is observed that they will give away food to conspecifics that give more food back (Hauser, 2003). *S. oedipus* also have certain food-associated calls in which they vocalize more when in close proximity to other individuals. There is no correlation, however, between the calls and the food quantity, quality, or distribution (Roush, 2000).

They have a variety of visual, auditory, and chemical signals that they utilize as forms of communication.

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They primarily use auditory and chemical cues but visual signals are used for close-up interactions between individuals. Vocalizations have significant differences in their meanings. "Chirps" and "slicing screams" are used in mobbing attacks of predators during feeding. "Long calls" are used in response to calls from distant animals. They use other forms of communication when in close proximity to one another, including "quiet long calls" and "trills." Chemical cues are also used for species identification and to detect ovulation in females. Females possess sweat glands around their genitals that tell the male when she is sexually receptive (Cawthon Lang, 2005).

Cotton-top tamarins typically live in groups of about two to seven individuals, although, groups of up to thirteen members have been recorded. The basic social system includes a reproductively active breeding pair as well as their offspring. Seven related *S. oedipus* in captivity at the Central Florida Zoo and Botanical Gardens were observed for this study. There is a mating pair as well as their offspring just as there would be in the wild. There are two pairs of twins and a set of triplets. Two of the individuals, one from the first set of twins and one from the set of triplets, are no longer in the habitat as of May 7, 2018 and are not included in this study. This leaves five of the offspring as a part of the observations. The mating pair is considered to be the most dominant in the wild. The mating female; however, is even more aggressive than its breeding partner in order to ensure food access (Cawthon Lang, 2005).

The focus of the study is to observe and record the activity budgets of each of the tamarins based on age. The goal is to monitor how active the tamarins are and how much they eat on an individual level. These data are then compared to determine whether the degree at which they are active and feeding changes drastically with age. It is hypothesized that the older cotton-top tamarin, Logan, will be less active and will feed less than the youngest tamarins, Ted and Hippo. Due to their critically endangered status, any information about cotton-top tamarins may help in reviving this species. Activity levels can show future researchers the impact that age can have on each individual tamarins and what precautions they may need to take with these older tamarins. The zookeeper may need to be more attentive to how the older tamarins are interacting with its younger relatives.

MATERIALS AND METHODS

This study was conducted in Sanford, Florida at the Central Florida Zoo and Botanical Gardens. The focus was a cotton-top tamarin family composed of seven members, four are females and three are males (Figure 2). The females include Gidget, Luna, Hippo, and Bey. The males consist of Logan, Ted, and Levi. Gidget and Logan are the breeding pair and the rest are their offspring. Two members of the *S. oedipus* family, Gidget and Luna, have cropped tails due to injuries acquired at a younger age. Each of their tails needed to be amputated, but this fact doesn't affect their ability to maneuver through the tree branches. Callitrichids do not have prehensile tails, unlike most other New World Monkeys, so they do not use their tails for grasping objects like branches. Table 1 contains a list of each tamarin with more information and some defining characteristics that help distinguish one another.

Figure 2. A photograph of all seven members of the S. oedipus family observed.

Names and Descriptions				
Name	Sex	DOB	Relation	Defining Characteristics
Logan	Male	11/28/05	Father	• Impressive gonads • Very vocal towards zookeepers
Gidget	Female	01/06/10	Mother	• Short tail • Leaky vulva
Luna	Female	03/13/15	First set of twins	• Short tail • Most wary of zookeepers • Small thick patch at base of tail
Levi	Male	02/07/16	Second set of twins	• Smallest • Slightly trimmer waist and gonads differentiate from Bey
Bey	Female	02/07/16	Second set of twins	• Larger than Hippo and Levi • Slightly frayed tail
Hippo	Female	09/30/16	Set of triplets	• Slight kink 2/3's way down tail that gives it a thicker appearance
Ted	Male	09/30/16	Set of triplets	• Slightly reduced hairline • Tail thins toward end and has a small poof at tip

Table 1

The study was conducted during the summer of 2018 for about ten weeks. The observations were performed twice a week for four hours each time. Observations were made outside the enclosure behind the barrier, the

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same location where the zoo visitors stand. The tamarins did not seem to acknowledge that research was being conducted; however, when the zookeeper arrived at about 11am to feed they became more active. Zoo visitors were always present while the study was in progress but did not seem to affect the behavior of the tamarins, aside from a few distractions.

The measurements used for this project are in units of time including hours, minutes, and seconds. Each individual tamarin was observed for a one-hour interval and the duration performed for each activity was timed during that allotted hour. Behaviors that were recorded included socializations, eating, alarm calls, grooming, and vocalizations. Other activities were also documented. For example, if Logan ate for thirty-two seconds at one time and then ate for another forty-eight seconds at another time during his assigned hour, then those times would be added together for a total of one minute and twenty seconds. This procedure was done for four different categories: (1) total time spent playing with other tamarins, (2) total time active, (3) total time spent grooming or being groomed, (4) total time spent doing other activities, such as observing and resting. Key behaviors are also stated in the observations. Play in this study is defined as physical and vocal interactions with another individual from the group – for example, chasing one another. Abnormal behaviors were classified as behaviors that are not seen in a typical behavior display. Becoming aggressive, attempting copulation, or performing an alarm calls are all examples of abnormal behaviors according to this study. Table 2 shows an example of the observation chart. The weather was taken into account as well and was recorded into the notebook every hour.

Name/Description	Behaviors
Gidget • Mother • DOB: 1/6/10 • Defining Characteristics: short tail, leaky vulva	Weather Condition: – Date/Time observed: – Total time observed: – Total time spent playing with other tamarins: – Total time active: – Total time spent grooming or being groomed: – Total time spent eating: – Total time spent doing other activities such as observing and resting:
	Normal Behaviors: •
	Abnormal Behaviors(?): •

Table 2

Their habitat includes a two-part exhibit with connecting tunnels between them. It is surrounded with a type of wire mesh that contains small holes to prevent the cotton-top tamarins from escaping due to their small body size. It features a variety of nest boxes, tree branches, ropes, and platforms for them to climb and leap on. Many of the branches and ropes are situated in a network of routes for them to explore. There are also vines and hammocks for the tamarins to play on. It is common for them to use tree branches for scent marking (French & Fite, 2005). *S. oedipus* have specialized skin glands in their genital areas that are larger in females than in males (Epple, 1988). This is verified in both Gidget and Luna. They both performed scent-marking behaviors numerous times in which they would rub their backside on a branch. Hippo participated in this behavior on one occasion as well.

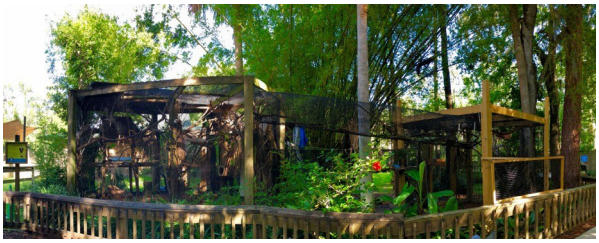

Figure 3. A photograph of the enclosure in which the S. oedipus family resides.

There are also many forms of enrichment inside the enclosure to help simulate the tamarins' natural environment. Enrichment is necessary for promoting behavioral and logical skills as well as mental and sensory stimulation (French & Fite, 2005). Every week the zookeeper adds new forms of enrichment, including toys, palm fronds, and PVC pipes to hang from. Their favorite types of enrichment are things that they can swing and climb on such as vertically hanging ropes or branches. A hammock was also added to their enclosure in which the tamarins immediately jumped on it. Their food is placed in different spots around the habitat to help maintain a sense of adventure for them. For example, the food may be in a coconut on top of some plant material or attached onto twigs sticking out from tree branches.

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RESULTS

Group Behaviors

Figure 4. A graphical representation of the cotton-top tamarin's total time for play and activity levels.

There are many different behaviors that were completed by the group as a whole. Hippo spent the most time active and playing with other tamarins, totaling 119 minutes. Logan, the oldest tamarin, spent the least amount of time performing active behaviors, totaling only 45 minutes. The other tamarins spent relatively the same amount of time active and playing with their relatives.

Alarm calls were also observed during this study. Alarm calls are a common behavior that is performed frequently when the tamarins feel threatened by a predator or even just see one in the distance. The *S. oedipus* in this study performed these alarm calls on numerous occasions when they saw ground predators as well as aerial predators. Alarm calls differ from other vocalizations because they are much louder and the tamarins are more alert. Their stance is more attentive and their call has much more of a shriek sound. Predators that cotton-top tamarins may come into contact with in the wild include hawks, snakes, and wild cats (a-z-animals.com). The first time the alarm calls were witnessed in this study was during the first week and it was due to a ground predator. This observation was made because their heads were facing downwards towards the ground. It is unsure if the predator was a ground-dwelling predator like a snake or something that resembled a snake. Another alarm call that was performed was directed at aerial predators. This behavior was observed various times and for many species of birds. During this call all of the tamarins became attentive and their tails puffed up. It is thought that because many of these tamarins were born in captivity they have a harder time distinguishing from predators and non-predators. They used their mobbing calls with birds, like blackbirds and buzzards, as well as service dogs. Although, these are not natural predators, they still used strong, high pitch vocalizations when they came into sight. A young girl wearing faux fur cat ears as well as a cat tail caused the tamarins to perform their alarm calls. They went as close to the girl as they could while using strong, high-pitch vocalizations (Figure 5). During week 10 the alarm call was set off by a white, fuzzy caterpillar.

Around 12 noon each day a squirrel would climb onto the enclosure scavenging for food. The tamarins rarely paid attention to it and left it alone. Occasionally, the tamarins will look at the squirrel but do not pursue it. They do not appear to perceive the squirrel's presence as a threat. Lizards catch their attention more often. Gidget attempted to attack one when it was on the side of the enclosure; however, it got away. Ants also cause curiosity in the tamarins, who include insects in their diet. However, they will not eat ants that enter the enclosure if they are reddish in color. They will only watch them as they climb along the wiring.

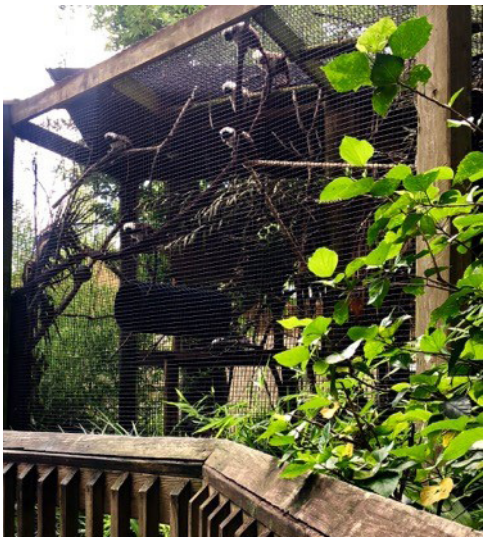

Figure 5. A photograph of six members of the S. oedipus family performing their alarm call due to a young girl wearing faux fur cat ears and tail (non-predator).

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Individual Behaviors

Gidget

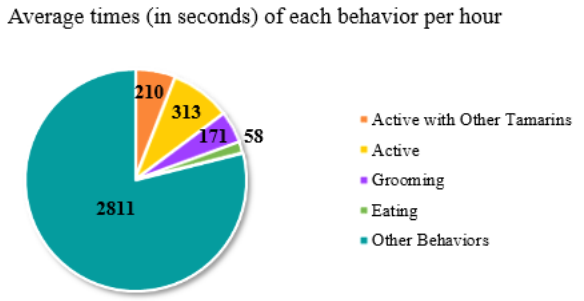

Figure 6. A graphical representation of the average times (seconds) Gidget performed each behavior.

Gidget is the mother of the group. She has a short tail that was due to an injury by one of her offspring, Stella. Stella is no longer in the habitat with the rest of the family due to her aggressive nature. Gidget is very curious and seems to be the most dominant member of the group. This observation is consistent with their behavior in the wild. The mating pair is supposed to be the most dominant, especially the breeding female. It is common that they are most aggressive when food is involved to ensure access to food items (Cawthon Lang, 2005). Gidget tends to be most hostile when there is food involved and will get into small fights occasionally. It is common for the mother of the group to display these aggressive behaviors. Even with these minor disputes, she is still not very aggressive and mostly gets along with the rest of the family. She was observed for a total of 9 hours and 55 minutes, and of this time, she spent an average of 3 minutes and 30 seconds each hour playing with other tamarins. This play includes chasing and tackling around the exhibit in a friendly manner. She spent an average of 5 minutes and 13 seconds active each hour. She mostly uses this time to explore the habitat and play with the enrichment items.

Logan

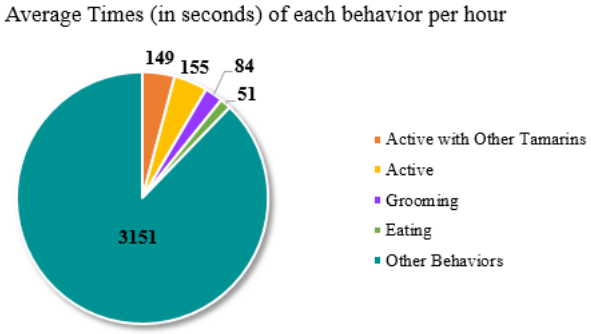

Figure 7. A graphical representation of the average times (seconds) Logan performed each behavior.

Logan is the father of the tamarin family and is the individual that is the most curious of the outside environment. He is very interested in visitors and doesn't usually get involved in too much play. He is the oldest of the group, which also makes him the least active; however, he is still playful. He spends an average time of 2 minutes and 29 seconds, or 149 seconds, each hour playing with other tamarins and an average time of 2 minutes and 35 seconds just being active. His activities include running on vines and jumping on ropes. He spends an average time of 51 seconds per hour eating. He participated in grooming for an average of 1 minute and 24 seconds. This average does not perfectly reflect his grooming habits. When Logan grooms, he grooms or receives grooming for long periods of time. Some days, for example on weeks 2, 4, and 5, he did not participate in grooming behaviors. He has the highest average time of observing and resting. He likes to spend most of his time sitting next to his mating partner, Gidget.

Luna

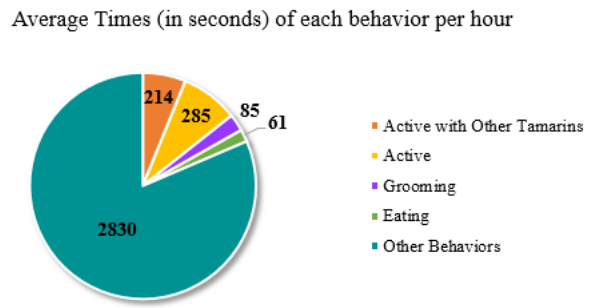

Figure 8. A graphical representation of the average times (seconds) Luna performed each behavior.

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Luna is a member of the first set of twins. Like her mother she has a docked tail which doesn't affect her mobility. She has an average time of 3 minutes 34 seconds, or 214 seconds, an hour playing and interacting with other tamarins. She also has an average time of 4 minutes and 45 seconds, or 285 seconds being active per hour. She performs grooming and eating behaviors for about an average of 1 minute and 25 seconds and 1 minute and 1 second, respectively. Her main activities include spending time near Logan and playing with the palm frond enrichment on the roof of the enclosure. She bites and grabs at the pieces dangling through the wire mesh. She likes to steal food from other tamarins in which they don't typically fight back. When she attempts to steal from Gidget, Gidget appears to become upset. As the pie chart depicts, she spends an average time of 47 minutes and 10 seconds per hour resting and observing the natural world or other family members.

Levi

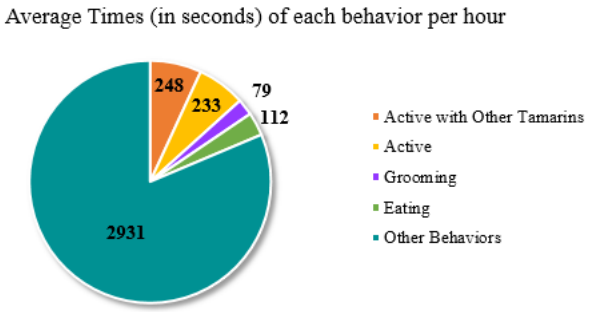

Figure 9. A graphical representation of the average times (seconds) Levi performed each behavior.

Levi is the smallest member of the S. oedipus family and is a part of the second set of twins. He likes to follow the group around but isn't the one that is involved in play the most. He has an average time of 4 minutes and 8 seconds an hour spent playing with other tamarins and an average time of 3 minutes and 53 seconds being active outside of interactions with other tamarins. Levi developed a small scratch under his eye which was most likely due to a fight with another tamarin. This fight was not observed, which is why it is not clear where the scratch came from. One activity that he likes to participate in is playing with the enrichment items. He likes the palm fronds and a new enrichment item in which he had to stick his limbs through small holes in a plastic box filled with hay in order to get the food. Normally he keeps his distance from the zookeeper; however, on week 5 he was the first to respond to the zookeeper. This change in behavior may be due to hunger since the keeper was bringing food for the group. He also tried stealing Gidget's food on week 5. He spends about 1 minute and 19 seconds, or 79 seconds, per hour on average grooming others or being groomed by others. He also spends 1 minute and 52 seconds on average eating and about 48 minutes and 51 seconds per hour inactive. During this inactivity, he is observing, resting, and scratching himself.

Ted

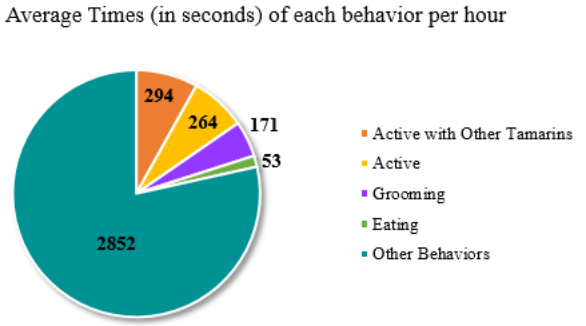

Figure 10. A graphical representation of the average times (seconds) Ted performed each behavior.

Ted is a member of the set of triplets born on 09/30/16. He spends an average time of 4 minutes and 54 seconds an hour playing and interacting with other tamarins. During his interactions, he mounted many members of his natal group. He would mostly mount Bey; however, he has also mounted Gidget. His penis is almost always erect and fully extended, possibly indicating that he is sexually frustrated and in need of copulation. He spends an average of 4 minutes and 24 seconds being active and an average of 2 minutes and 51 seconds per hour grooming others or being groomed himself. He spends the second most time allogrooming next to his mother who had the highest average time of grooming. He is very social and spends an average of 53 seconds an hour eating. He spent many of the weeks not eating at all. He seems to be more interested in grooming others than eating. He has been seen to eat on other occasions that are not during his assigned time. He also spends about 47 minutes and 32 seconds on average each hour resting and observing. Ted was removed from the enclosure during week 8 due to a veterinary appointment. When he returned to the exhibit, he was separated from the rest of the family to see how he acclimates to being back. He was anxious at first, but he eventually became calm and laid down on a branch for the duration of his seclusion.

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Hippo

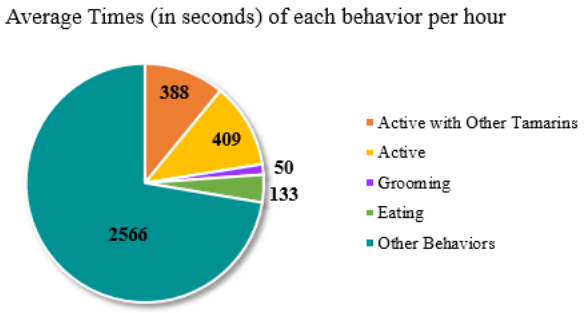

Figure 11. A graphical representation of the average times (seconds) Hippo performed each behavior.

Hippo is also a member of the triplets and is the the most active and playful of all the tamarins. She plays with others each designated hour for an average time of 6 minutes and 28 seconds, or 388 seconds. She is active for about 6 minutes and 49 seconds per hour. She played with the same hanging plastic basket that Levi was interested in. She played with it for about 25 minutes and continuously got food from it to eat. This play was interrupted by a hawk that flew overhead causing an alarm call. She spends about 50 seconds per hour allogrooming and 2 minutes and 13 seconds eating. Otherwise, she spends about 42 minutes and 46 seconds an hour observing other tamarins play and watching the guests walk by.

Bey

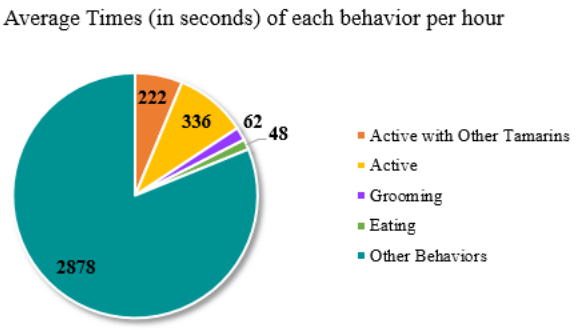

Figure 12. A graphical representation of the average times (seconds) Bey performed each behavior.

Bey is a member of the second set of twins. She has a similar activity level to Hippo with an average active time per hour of 5 minutes and 36 seconds. She plays with her siblings and parents an average of 3 minutes and 42 seconds an hour. Her favorite play partner is Hippo. They run back and forth throughout the enclosure and will bounce off ropes. She doesn't spend a lot of time eating or grooming—the average times per hour are 48 seconds and 62 seconds, respectively. She is very vocal and tried to steal food from Hippo during week 2 of observations. She spends an average time of 47 minutes and 58 seconds each hour resting and observing her surroundings. During week 9, Bey displayed sickly behaviors in which she would gag and regurgitate the contents in her stomach. The zookeeper was alerted immediately and it was determined that the episode was most likely due to her choking on food. An indication that it was choking was due to her behaviors while she was throwing up. She would play with Hippo and then vomit and then continue playing, meaning she most likely did not feel ill.

DISCUSSION

The main goal of this paper was to determine whether the activity budgets of the older cotton-top tamarin's differed from the activity budgets of the younger ones. It was hypothesized that the older *S. oedipus,* Logan, will have lower activity levels and will feed less often per hour than the younger tamarins, Hippo and Ted. Previous studies have indicated that as primates age their physical capabilities decrease. This trend occurs in both human and non-human primates (Almeling, 2016). The hypothesis appears to be supported based on the observations conducted in this study, although, more data would need to be collected in order to adequately evaluate the hypothesis statistically. The average time Logan performed activities, such as playing with other tamarins as well as just being active, was the lowest of all the family members. Hippo, born September 30, 2016, had the highest activity levels. This result is represented in Figure 4. There was room for error with the hypothesis because the second oldest tamarin, Gidget, had a higher activity level than did some of the offspring, Luna and Levi.

Weather and temperature have an effect on the behaviors of the captive *S. oedipus.* During the hotter temperatures, about 88˚F and higher, the tamarins become inactive and will hide in the shade. When the temperature is about 78˚F to 87˚F the tamarins were more active. Rain also had an impact on the behaviors of the cotton-top tamarins. They became very inactive during the rain and will huddle under the covered part of the exhibit. Logan, the father, will leave the huddle to check if the

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rain has passed and will then return to the group to alert the others of his findings. If the rain stopped, he will use a vocalization to express this fact and then the rest of the group will return to their normal behaviors throughout the enclosure. If the rain has not stopped, they will continue to sit under the cover and wait for the weather to pass.

The time of day also has an effect on the cotton-top tamarins. This has a direct correlation with the temperature. The study was mostly performed between the hours of 10 am and 2 pm, with the exception of one day. Between 10:00 am and 11:30 am, activity levels are high. From about 11:30 am to 12:30 pm, activity levels are lower and the tamarins will rest and groom one another. There was typically less cloud cover and higher temperatures during this time, which indicates that they are less active in the heat. Between 12:30 and 2:00 pm, they become more active again. The storm clouds begin to appear at this time, decreasing the temperature, and allowing the tamarins to become more active once again. This is not a perfect observation due to the variety of factors involved. The storm cloud coverage varies, but these are the most frequent findings observed.

S. oedipus' reproductive behavior varies between the wild and in captivity. Cotton-top tamarins only reproduce once a year in the wild (Savage, 1997). This fact is most likely due to energy expenditure. Mothers carry their infants for a long period of time after their birth, resulting in less time and more energy needed for feeding. Due to this energy burden, they reproduce less often in the wild. In captivity, it is common for a female callitrichid to give birth twice a year. For example, two of the sets of tamarin offspring observed in this study were born in the same year. The second set of twins were born on February 7, 2016 and the set of triplets were born on September 30, 2016. The reason there may be more than one pregnancy in a year for captive cotton-top tamarins is most likely due to increased access to food. The mothers won't have to search for food, so she is able to spend more of her energy on raising her offspring with the help of the other family members.

The alarm calls in relation to non-predators could have been due to curiosity, making it an aggregation call. The tamarins, especially Bey, were attempting to grab and bite at the caterpillar, meaning the call was most likely about a potential food source. This is another example of a non-predator mobbing call. For aerial predators, they began their alarm calls with a two-tone high pitch vocalization to serve as a warning. This alarm gets the attention of the rest of the tamarins, who look to the sky for a threat. If the predator is out-of-sight they will keep watch but do not continue their call. If the predator stays in view, they will continue their alarm call in which all participate. This study was unable to conclude whether or not the ground predator and aerial predator alarm calls differ.

A study by Sheryl Hayes and Charles Snowdon researched the predator recognition in captive cotton-top tamarins (Hayes, 1990). Their findings are consistent with the observations seen in the tamarins involved in this study. Their study consisted of using predator and non-predator stimuli and recorded their reactions, including vocalizations. They were attempting to determine if the tamarins recognize a snake, a natural predator, as a danger as well as to see if their response was specific to snakes (Hayes, 1990). The tamarins were presented with a live snake along with inanimate objects during one occasion. The *S. Oedipus* family emitted strong alarm and mobbing vocalizations while the snake was present, unlike when the inanimate objects were in view. Their vocalizations were determined to have no significant difference in avoidance behavior as would be expected of wild *S. oedipus*. On a separate occasion they were shown a laboratory rat, a non-predator, as well as leaves and an empty box. There was also no significant difference between the mobbing calls between the presentations of the snake versus the rat (Hayes, 1990). This observation suggests that captive tamarins do not have alarm specific calls to predators only (Hayes, 1990). They seem to demonstrate a fear of moving objects that do not look like humans. This could also better explain their reactions to the caterpillar as well as the girl with the faux fur cat ears and tail discussed previously. They are used to humans passing by their exhibit, but the caterpillar, the young girl, and the service dogs set off their mobbing calls.

According to Ginther (2001), the males were more often the recipients of mounting behavior. This was not the case in this study. The males were rarely recipients of any mounting. There was only one recorded incident where a male was mounted by another tamarin. The mounting tamarin was when the dominant female, Gidget. It was not determined who the mounted tamarin was but it was presumed to be Logan. Once Gidget finished mounting Logan, she exposed her genital area to his face. This may have been to give off a chemical signal in order to present herself as ready to mate.

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Ted is one of the youngest offspring of the breeding pair. He has reached sexual maturity and is ready to mate; however, there are only family members available to breed with. In the wild, when a male is ready to mate with a female he will leave his natal group and venture to neighboring groups looking for viable females (Cawthon Lang, 2005). This absence of mates could be causing the copulation attempts by Ted.

There were many limitations of observing the cotton-top tamarins in a zoo setting. One limitation was that due to their small body size they are very hard to locate and distinguish. Another was that the visitors were sometimes a distraction, making it hard to compare their behaviors to those of wild tamarins. Being enclosed in a specific habitat also made it difficult to predict how they would normally range outside in their natural environment. Studies based on relationships with neighboring groups could not be observed because they were only in contact with their own natal members. Also, the time constriction of the study allowed for a lack of completely conclusive results. A continuation of this study would result in more definite data and statistical analyses can then be conducted. Further research would continue observations of the interaction between each family member and to also look at male versus female interactions.

The observations made on cotton-top tamarins can help future researchers better understand the social interactions between related individuals. Their behavior in captivity has relevance to understanding their behavior in the wild. Captive *S. oedipus* observations can have implications in how the species might survive and persist with human-induced changes in the environment. Urbanization is a rapidly occurring event that is taking over the habitats of cotton-top tamarins, so observing their behaviors in captivity may thus give us an idea on how this species will cope with this changing environment. Studying the interactions between cotton-top tamarins is also important in understanding the uses for their vocalizations, including alarm calls. Their small size and narrow habitat range can make it difficult to study them in the wild, so it is key to gather as many observations as possible while they are in captivity. *S. oedipus* are critically endangered and any research developed can be vital for the future of cotton-top tamarins. Public engagement and other conservation efforts are also crucial to increasing their populations.

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