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Effect of Group Size on the Activity Budget of Two Captive Chimpanzees (*Pan troglodytes*)

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EFFECT OF GROUP SIZE ON THE ACTIVITY BUDGET OF TWO CAPTIVE CHIMPANZEES (*PAN TROGLODYTES*)

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ABSTRACT

EFFECT OF GROUP SIZE ON THE ACTIVITY BUDGET OF TWO CAPTIVE CHIMPANZEES (*PAN TROGLODYTES*)

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Captive facilities housing chimpanzees are required to provide adequate care and provisions such as dietary, social, and environmental enrichment to promote the psychological well-being of the apes in their care. Chimpanzees are social creatures and changes in groups as well as relocation to a facility with new social partners, can impact each individual chimpanzee's welfare. By tracking each chimpanzee's activity budgets, managers can assess welfare and make improvements or adjustments if necessary. I looked at the activity budgets of two captive chimpanzees after the death of a group member and the two chimpanzees' subsequent relocation to a novel, more socially complex environment. Data collection took place during three conditions of social grouping: when the two chimpanzees lived in a long-term group with a third member, when they lived as a pair, and after their move to a sanctuary with 11 other chimpanzees. Data coders recorded the behavioral context of both chimpanzees during each condition. The results supported the hypothesis that upon relocation to an environment with additional conspecifics, social behaviors such as grooming and play increased.

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CHAPTER I

INTRODUCTION

Captive facilities housing chimpanzees and other non-human primates are required by law to provide adequate care and provisions such as dietary, social, and environmental enrichment to promote species-typical behaviors and cultivate the psychological well-being of the residents (APHIS, 2017). In order to promote species-typical behaviors, managers should try to recreate free-living chimpanzee communities in all aspects of care (Bloomsmith & Baker, 2001). To encourage such behaviors, Coe, Fulk, and Brent (2001) suggest two features of captive management: complexity and control. Fouts, Abshire, Bodamer, and Fouts (1989) note that there are distinct differences between the complexities of free-living environments and the potential lack of complexity and control in captive environments. Choices, such as traveling between spaces and social groups as well as selection of food and environmental manipulation, are central to any captive setting (Kulpa-Eddy, Taylor, & Adams, 2005).

Assessing the activity budgets of captive chimpanzees may allow researchers and caregivers to recognize deficiencies in captive environments (Yamanashi & Hayashi, 2011). An activity budget is defined as the time an individual spends in each activity throughout the day (Jaman & Huffman, 2008). Activities include feeding, social grooming, self-grooming, travel, resting, and similar categories (Isbell & Young, 1993). Comparing activity budgets of free-living and captive chimpanzees is a simple way to measure the efficacy of procedures in place to promote species-typical behaviors. Because facilities must provide dietary, social, and environmental enrichment in order to elicit

species-typical behaviors, behaviors such as foraging, traveling, and resting should be included in the assessment of activity budgets of captive chimpanzees. Additionally, a variety of environmental enrichment protocols, such as problem solving, structures, tools, and objects should be available to promote the behaviors mentioned above.

A number of field sites have reported the activity budgets of free-living chimpanzees including Gombe (Goodall, 1986; van Lawick-Goodall, 1968), Bossou (Matsuzawa, Humle, & Sugiyama, 2011; Sugiyama, 1989, 2004), Budongo (Reynolds, 2005), Kibale (Chapman & Wrangham, 1993; Ghiglieri, 1984; Watts, 2012), Mahale (Nishida, 1990, 2012), and the Tai Forest (Boesch & Boesch, 1984; Boesch & Boesch-Achermann, 2000); however, there is a shortage of data on the activity budgets of chimpanzees in various sanctuary environments.

I compared activity budgets between two captive group settings. I followed two adult chimpanzees and their move from a group living at the Chimpanzee and Human Communication Institute (CHCI) to a facility housing a fission-fusion group at the Fauna Foundation. The results of this study will document the changes in activity budget seen after group size increased from two to a group of four with visible and protected access to seven other chimpanzees. Results from this study will allow other facilities housing chimpanzees to assess effective group size to support the psychological well-being of chimpanzees and provide baseline information on activity budgets in sanctuary.

CHAPTER II

LITERATURE REVIEW

Free-living Chimpanzee Activity Budget

Pruetz and McGrew (2001) created a 24-hour daily activity budget for free-living chimpanzees using data collected over 50 years from Gombe (*Pan troglodytes schweinfurthii*), Bossou (*Pan troglodytes verus)*, Budongo (*Pan troglodytes schweinfurthii),* Kibale (*Pan troglodytes schweinfurthii),* Mahale (*Pan troglodytes schweinfurthii),* and the Tai Forest (*Pan troglodytes verus)* field sites. Chimpanzees allocated 27.5% of time towards foraging, 9% towards resting, 8% towards travel, 4% towards social interaction, 50% towards sleeping, and 1.5% towards miscellaneous activities.

Social Lives of Chimpanzees: Welfare Concerns

Experts in chimpanzee behavior agree that social housing is one of the most crucial factors in captive chimpanzee welfare (National Institutes of Health, 2013). The Association of Zoos and Aquariums (AZA) Ape Taxon Advisory Group (2010) suggests careful consideration when forming captive chimpanzee groups. Group size should meet the social, physical, and psychological well-being requirements of these non-human animals and should facilitate species-typical behaviors. Free-living chimpanzees live in a fission-fusion society, comprised of anywhere from 20-150 individuals (Lehmann & Boesch, 2004). Fission-fusion societies divide into subgrouping with party sizes ranging from 4.0-8.3 with the average size of 5.7 (Pruetz & McGrew, 2001). Bloomsmith and Baker (2001) note that it is of critical importance that captive chimpanzee managers take

into account the social characteristics of free-living chimpanzees and apply aspects of their sociality to captive populations. They suggest, "the environment of captive chimpanzees must focus on defining and providing appropriate social environments" (p. 205). The United States Department of Agriculture (USDA) also requires that facilities housing non-human primates provide for social groupings according to the species-typical group size in nature (APHIS, 2017). The National Institutes of Health (NIH) recommends that chimpanzees in captivity live in groups consisting of no less than three individuals, with seven individuals as the ideal number (National Institutes of Health, 2013). Additionally, captive groups should contain individuals of varying age and sex. Groups comprised of mixed ages and sexes allows for the expression of affiliative behaviors that may differ between the sexes (Baker, 2000; Huffman, 1990; Goodall, 1986; Nakamura, 2003; Webb, Hau, & Schapiro, 2018).

Wobber and Hare (2011) note that chimpanzees that are deprived of proper social environments, especially those living in isolation, show "extreme levels of aberrant behaviors, including social and cognitive deficits that prevented these individuals from copulating, raising infants, or having a normal social life more generally" (p. 1). Chimpanzees and other non-human primates raised in isolation, without conspecifics, show an increase in stereotypical and self-directed behaviors. These behaviors include rocking, swaying, thumb-sucking, eye-poking, biting, over-grooming, fear of novelty, ingestion of urine and feces and long-term behavioral abnormalities (Baker, 1996; Berkson, 1968; Bloomsmith & Else, 2005; Brent, Lee, & Eichberg, 1989; Davenport & Menzel, 1963; Davenport, Menzel, & Rogers, 1966; Ferdowsian et al., 2011; Harlow,

Dodsworth, & Harlow, 1965; Menzel, 1964; Pazol & Bloomsmith, 1993; Spijkerman, Dienske, van Hoof, & Jens, 1994; van Leeuwen, Mulenga, & Chidester, 2014; Walsh, Bramblett, & Alford, 1982; Wobber & Hare, 2011)

Social grooming is a critical species-typical behavior that plays a role in sociality among chimpanzees (Koski, de Vries, van de Kraats, & Sterck, 2012). Social grooming is defined as the "use of both hands to part the hair of a conspecific while picking at that individual's exposed skin with lips, thumb, or index finger" (Wobber & Hare, 2011, p. 4). Mutual grooming, in which both partners groom each other simultaneously, is very common in chimpanzee populations. (Fedurek & Dunbar, 2009; Nakamura, 2000). Mutual grooming requires both partners to cooperate and is a good indicator of social bonds within a pair. Mutual grooming serves to solidify relationships among chimpanzees.

Chimpanzees in free-living populations spend a large portion of their waking time grooming with others (Goodall, 1986). Nakamura (2003) studied the grooming behavior of M group chimpanzees living in Mahale Mountains National Park, Tanzania. M group contained 56 individuals of varying age and sex. Researchers recorded the instances of social grooming in groups larger than two individuals. Grooming bouts can include 10 or more individuals and may contain multiple simultaneous interactions with multiple conspecifics (Nakamura, 2003). Nearly 70% of all grooming time was spent in polyadic grooming clusters. Males preferred to groom in clusters of two to four individuals, while females preferred groups containing five or more individuals.

Some chimpanzees may spend more than 25% of their time grooming (Goodall, 1986; Kawanaka, 1989). This type of social grooming plays a role in the fission-fusion

society of chimpanzees. Chimpanzees interact with a large range of individuals throughout the day and grooming provides an opportunity for bonding with a broad range of individuals (Nakamura, 2003).

Providing Environmental Enrichment

Opportunities for social interaction are an important welfare component among captive chimpanzees; however, social living is not the only aspect that needs to be considered when caring for captive apes. Robert Yerkes first introduced environmental enrichment to the animal husbandry world in 1925. Yerkes wrote "the greatest possibility for improvement in our provision for captive primates lies with the invention and installation of an apparatus, which can be used for play or work" (Yerkes, 1925, p. 129). In 1966 the USDA put into law the Animal Welfare Act. This is the only Federal law in the U.S. that regulates the care and treatment of animals in research, zoos, and commercial sales. In 1986, the USDA required the additional provision of providing for the psychological well-being of non-human primates. With this began a surge in providing environmental enrichment. Environmental enrichment is "the provision of animate, inanimate and nutritional environmental modifications that promote the expression of species-appropriate behaviors and species-appropriate mental activities" (Reinhardt & Reinhardt, 2008, p. i). Additionally the USDA requires that facilities housing non-human primates "must develop, document and follow an appropriate plan for environmental enhancement adequate to promote the psychological well-being of nonhuman primates" (APHIS, 2017, p. 175).

Opportunities for Foraging

When considering the effectiveness of environmental enrichment, the USDA and the AZA require programs to allow for affiliative contact with other primates, normal nesting opportunity, comfort-seeking behaviors, self-maintenance behaviors, normal locomotion behaviors, and cognitive behaviors through exploration and foraging (APHIS, 2017; AZA Ape TAG, 2010).

Baker (1997) studied the benefits of straw bedding and forage material on the abnormal behavior of 13 indoor-housed chimpanzees living at Yerkes Regional Primate Research Center. Chimpanzees received bales of straw for nesting materials. They had an intact bale and the opportunity to disperse the straw for proper nesting. Additionally, the chimpanzees received foraging materials including sunflower seeds, peanuts, and chicken scratch. There was a significant decrease in abnormal behaviors including regurgitation and reingestion, coprophagy, urophagy, and hair plucking following the implementation of foraging and nesting materials (Baker, 1997). Additionally, the author notes that with the implementation of enrichment, unfavorable behaviors decreased but positive interactions, such as play, increased. These findings supported previous studies that showed opportunities for foraging and bedding materials decreased the instances of abnormal behavior in captive orangutans and juvenile chimpanzees (Bloomsmith, Alford, & Maple, 1988; Brent, 1992; Tripp, 1985).

In addition to foraging opportunities, chimpanzees should have activities to promote mental stimulation (Byrne, 1999; Pawlowski, Lowen, & Dunbar, 1998). Free-living chimpanzees spent 22.5% to 60% of their time foraging and eating (Boesch &

Boesch-Achermann, 2000; Doran, 1997; Matsumoto-Oda, Hosaka, Huffman, & Kawanaka, 1998; Pruetz & McGrew, 2001; Wrangham, 1977; Yamanashi & Hayashi, 2011); however, in captivity, food is easily processed and distributed with the help of human caregivers. Baker (1997) and Bloomsmith et al. (1988) suggested increasing feeding and foraging behavior with the use of food-based enrichment.

Yamanashi and Hayashi (2011) designed a study that addressed both the cognitive needs of chimpanzees as well as foraging needs. The study directly compared behaviors between free-living and captive chimpanzees to assess the effects of cognitive experiments as a means of enrichment. They collected data on 12 chimpanzees of varying age and sex living at the Primate Research Institute (PRI) in Aichi, Japan. Chimpanzees were invited to participate in cognitive experiments that resulted in food rewards throughout the day. Data were collected for a total of 227.05 h from December 2009 to February 2010. With the implementation of cognitive experiments, feeding and resting times were similar to free-living chimpanzees. Free-living chimpanzees problem solve when obtaining food and this type of enrichment promoted that behavior.

Tool Use and Object Manipulation

Free-living chimpanzees frequently use tools as part of their feeding ecology. Tool use includes the application of termite and ant fishing (Sanz & Morgan, 2009), pestle-pounding (Goodall, 1986; Yamakoshi, 1998), honey dipping (Sanz & Morgan, 2009), breaking nuts with stone and wood tools (Boesch & Boesch, 1984; Hannah & McGrew, 1987), and hundreds of other types of tools. Enrichment programs should provide opportunity for tool use in order to promote species-typical behaviors.

Celli, Tomonaga, Udono, Teramoto, and Nagano (2003) designed a study to mimic tools used for insect fishing. The participants were six adult female chimpanzees. The task simulated ant-fishing behavior of free-living chimpanzees with honey as the reward. The chimpanzees received a choice of tools including plastic brushes, wires, metal chains, strings, bolts, vinyl pouches, plastic spoons, metal pins, rubber tubes, wooden chopsticks, etc. ranging in length and diameter. The authors provided materials that were not necessarily appropriate for the task at hand, but rather served to stimulate cognition and assessment of chimpanzee tool choice. Given the opportunity for fishing, inactive time decreased by 52%, and foraging time increased by 31%. Additionally, tool use and manipulation rose from 0.7% during baseline measurements to 8.6% during test conditions.

Similar studies show that chimpanzees in captivity use tools in similar fashion to their free-living counterparts. This type of tool use includes honey fishing (Hirata & Celli, 2003; Hirata & Morimura, 2000), termite fishing (Nash, 1982; Hopper, Tennie, Ross, & Lonsdorf, 2015), and nut cracking (Sumita, Kitahara-Frisch, & Norikoshi, 1985). Additional studies show that the implementation of puzzle feeders, which require tools to retrieve food items, decreased group aggression, self-directed behaviors, and abnormal behaviors (Brent & Eichberg, 1991; Maki, Alford, Bloomsmith, & Franklin, 1989).

Nest Building and Rest

Nest building and rest play major roles in the lives of free-living chimpanzees. Free-living chimpanzees spend approximately 12 hours of each 24-hour cycle resting (Pruetz & McGrew, 2001). Chimpanzees make nests from branches and leaves, elevated at

least 10 m off the ground and rest in nest sites both at night and during the day (Fruth & McGrew, 1998; Fruth & Hohmann, 1996). Videan (2006) conducted a study of 20 captive chimpanzees in multiple groups ranging from three to five individuals living at the University of Texas MD Anderson Cancer Center in Bastrop, Texas, and the Southwest Foundation National Primate Research Center in San Antonio, Texas. Researchers recorded the nocturnal behavior of each group of chimpanzees over eight months. Chimpanzees sleep on average 8.81 h per night (Videan, 2006). They did not sleep through the night and woke up on occasion to eat and drink. Also some instances of social grooming and copulations occurred.

To properly mimic free-living nesting, captive chimpanzees must receive adequate nesting materials. The NIH Council of Councils Working Group on the Use of Chimpanzees in NIH-Supported Research suggests that soft and flexible materials such as hay, browse, and blankets be provided to chimpanzees to make nests (National Institutes of Health, 2013). Resting should be considered an important component to captive chimpanzee care during both the day and night (AZA Ape TAG, 2010).

Enclosure Design

When creating enclosures for captive chimpanzees, researchers must consider necessary space use for resting, locomotion, and travel. Free-living chimpanzees spend 10-20% of their day traveling and typically climb five to ten trees per day depending on the group (Boesch & Boesch-Achermann, 2000; Wrangham, 1992). The NIH (2013) and the AZA Ape TAG (2010) suggest that ethologically appropriate habitats should contain proper space and devices to allow for traveling, climbing, and brachiating. Jensvold, Sanz,

Fouts, and Fouts (2001) found that following a move to a larger, more spatially complex facility, five captive chimpanzees traveled more and displayed more species-typical behaviors. In similar studies of space use, captive chimpanzees preferred spaces with higher elevations (Ross, Calcutt, Schapiro, & Hau, 2011; Ross & Lukas, 2006). As a result, the AZA Ape TAG (2010) recommends that chimpanzees have opportunities to climb to heights of at least 20 ft (6.1 m). Wilson (1982) also notes that complexity and quality of space is an important factor to consider in habitat construction. Complex environments can include various substrates and climbing structures for movement, travel, escape, nesting, and location preference (Baker, 1997; Brent, 1992; Pruetz & McGrew, 2001; Ross, Schapiro, Hau, & Lukas, 2009).

Changes in Group Dynamics

Group dynamics change frequently in free-living chimpanzee society. The fission-fusion lifestyle of chimpanzees allows for fluctuations in population densities. Unfortunately, most zoos, sanctuaries and labs with chimpanzees are not able to recreate the fluidity between groups and thus cannot fully mimic free-living communities. Few studies have addressed the changes in group dynamics of an established a biologically unrelated family of captive chimpanzees.

Several researchers studied free-living chimpanzees' responses to the death of community members (Anderson, 2011; Anderson, Gillies, & Lock, 2010; Cronin, Van Leeuwen, Mulenga, & Bodamer, 2011; Stewart, Piel, & O'Malley, 2012). Cronin et al. (2011) reported various responses to the death of an infant including touching, grooming, inspecting, peering, and movement of the corpse. Stewart et al. (2012) reports similar

passive inspection of the corpse. Additionally, Stewart et al. (2012) noted more aggressive responses to the death of an adult member including shaking, dragging, and beating of the deceased.

Age may also play a role in the behavior of chimpanzees. As chimpanzees age, Goodall (1986) reports weight and bone loss as well as loss in mobility. Similarly, aged chimpanzees may differ in social interactions when compared to their younger conspecifics. Males tend to associate less with other group members with the exception of dominant males (Huffman, 1990; Kawanaka, 1993). Female associations tend to shift towards their offspring and grandoffspring (Goodall, 1986). Baker (2000) studied the effects of aging on a population of 14 female and 20 male adult chimpanzees living at the Yerkes Regional Primate Research Center in Atlanta, Georgia. Unlike free-living populations, sociality did not change among captive chimpanzees; however, as individuals aged, there was a decrease in aggression in both males and females and an increase in submissive behaviors in females.

Relocation to a Novel Environment

Both relocation to a new environment and the introduction to a new social group impact the behavior of captive chimpanzees. During the first phase of relocation, chimpanzees may show signs of physiological and psychological stress (Schapiro et al., 2012). Schapiro et al. (2012) relocated a group of 72 chimpanzees between two research facilities, one in Arizona and one in Texas. The chimpanzees were moved in single transport cages but remained in groups or pairs upon arrival. Using blood draws during anesthesia, welfare-related physiological measures returned to pre-transport levels six

weeks after relocation. Other variables such as hematological responses had not returned to pre-transport levels 12 weeks after relocation. Unfortunately, this study used invasive techniques such as blood draws to assess welfare. Techniques like this could have played a role in the results and stress levels for the chimpanzee's involved. Similarly, Bloomsmith, Schapiro, and Strobert (2006) suggest that to ensure welfare, chimpanzees should be transported and relocated with a stable social group. Once a group has been relocated, special precautions should be taken in order to introduce chimpanzees to new conspecifics. Free-living chimpanzees are territorial and can show lethal aggression towards newcomers in their groups (Goodall, 1986). During introductions, chimpanzees show higher levels of aggression towards both in-group and unfamiliar chimpanzees (Brent, Kessel, & Barrera, 1997; Fritz & Howell, 2001; Schel et al., 2013); however, over time and successful introductions, affiliative behaviors increase with group cohesion (Schel et al., 2013). For example, Schel et al. (2013) successfully combined two pre-existing groups living at the Edinburgh Zoo. Social group formation took place gradually over 16 months. The chimpanzees were physically and visually separated and then gradually introduced first visually and then individually to members of the other group. After both groups were successfully introduced, grooming between members of previous groups remained the same as before the introduction. Furthermore, they saw a significant increase in the grooming rates between group one and group two. Thus, the introduction and incorporation of new group members may correspond with a change in activity budgets.

Caring for a Family of Cross-Fostered Chimpanzees

The two participants in this study, Tatu and Loulis lived with three other chimpanzees (Washoe, Moja and Dar) from 1981 to 1993, in the Psychology building on the Central Washington University (CWU) campus. In 1993, the group of five chimpanzees moved into a new, state of the art building known as the Chimpanzee and Human Communication Institute (CHCI), with 587 m^2 of indoor and outdoor space (Jensvold, Sanz, Fouts, & Fouts, 2001). Throughout their lives, the chimpanzees received daily dietary, social, and environmental enrichment as a regular part of the enrichment program in place at the CHCI (Fouts, Bodamer, & Fouts, 1990; Fouts et al., 1989).

In 2002 Moja passed away, followed by Washoe in 2007, and Dar in late 2012. In 2013, when only Tatu and Loulis remained at the CHCI, they were moved to Fauna Foundation in Carignan, Quebec. Established in 1997, Fauna Foundation provides a permanent home for chimpanzees and other non-human animals. At the time of the study, Fauna Foundation had 11 chimpanzees with various backgrounds including former pet, ex-entertainment, retired biomedical, and ex-zoo residents. Fauna Foundation is unique in that it provides fluid group movement for the chimpanzees. Doors between enclosures are strategically placed to give individuals the opportunity to socialize with other chimpanzees and move between compatible subgroups.

The Current Study

The purpose of the current study was to assess the change in activity budget of Tatu and Loulis between two different social conditions. The baseline condition was when Tatu and Loulis lived in a group of three chimpanzees (Tatu, Loulis and Dar) at the CHCI

(Fall 2012). The first condition occurred in Spring 2013 when only Tatu and Loulis were in the group living at CHCI. The second condition occurred in Winter 2014 when Tatu and Loulis with a group of four with Sue Ellen and Spock at the Fauna Foundation. The two conditions were compared to the baseline since Tatu, Loulis and Dar lived together as a group of three for five years before the study began. The NIH suggests that three individuals is the minimum requirement for social housing and formed the baseline for my study.

The first hypothesis was that there would be a decrease in social behaviors such as grooming, play, agonistic encounters and threat behaviors in the Spring 2013 condition versus the baseline. The second hypothesis was that there would be an increase in social behaviors such as grooming, play, agonistic encounters and threat behaviors in the Winter 2014 condition versus baseline.

CHAPTER III

METHODS

Chimpanzee Participants

The two participants in this study were two adult chimpanzees, Tatu and Loulis. Tatu and Loulis lived at the CHCI on the campus of CWU in Ellensburg, Washington. Both chimpanzees lived together at the CHCI from 1981 to 2013. On August 28, 2013 both Tatu and Loulis moved together to the Fauna Foundation in Carignan, Quebec.

Tatu was born on December 30, 1975 and was cross-fostered and raised as a deaf-human child, with other cross-fosterlings, Moja, and Dar. Tatu learned American Sign Language (ASL) similar to the way hearing children learn vocal speech (Gardner & Gardner, 1978, 1984, 1989).

Loulis was born on May 10, 1978 and was adopted and raised by Washoe, acquired ASL from his chimpanzee family (Fouts, Hirsch, & Fouts, 1982; Fouts, Fouts, & Schoenfeld, 1984; Fouts, Fouts, & Van Cantfort, 1989). Washoe was the first non-human to acquire a human language and was the sole participant in the first cross-fostering project of Allen and Beatrix Gardner. Loulis was introduced to Washoe in 1979 when he was 10 months old while Washoe lived at the Institute for Primate Studies in Norman, Oklahoma. Shortly after they met, Moja joined Washoe and Loulis in Oklahoma. In 1980, Dr. Roger Fouts moved Washoe, Moja and Loulis to the Psychology building at (CU. After the move, Tatu and Dar joined the family of chimpanzees in the same building at CWU. They had 27.8 m^2 of space with no outside access.

Chimpanzee and Human Communication Institute

The CHCI was a 650 m^2 facility that contained four night enclosure rooms, two large playrooms and a large outdoor area. The chimpanzees had access to the large play rooms and the outdoor area during the hours of 9:00 a.m. to 12:00 p.m. and 1:00 p.m. to 3:30 p.m. Monday through Saturday. Caregivers offered breakfast to the chimpanzees upon arrival at 8:00 a.m. every morning. Once meal service was finished, the chimpanzees received access to the two large playrooms and the large outdoor area. At 11:30 a.m. caregivers invited the chimpanzees into the night enclosure area for lunch. On or around 1:00 p.m. the chimpanzees received access to the larger areas and outdoor area again until 3:30 p.m. At 3:30 p.m. caregivers invited the chimpanzees into the night enclosure area for dinner. If they chose to come in, they remained in the night rooms until the following morning. The night enclosure area was where almost all meal service occurred. Between meals, caregivers served snacks throughout the facility.

Meal times were on a schedule and the meal was available for one hour. The chimpanzees had a choice to come inside the night enclosure area for a meal or stay out and forego the meal. If any chimpanzee skipped a meal, caregivers offered no subsequent snack. There was variety in produce and cooked meals day to day and there was a set menu for each meal with an alternative of primate chow. For example, at lunch a chimpanzee's choice may have been white bean soup and/or primate chow followed by fresh vegetables. Meals were served in portions of one cup or more.

Environmental enrichment and nesting materials were available to the chimpanzees. The chimpanzees received new items such as magazines, tubes, mirrors,

brushes, clothes, masks, drawing materials, laminates with images, sheets, and a variety of cloth materials. At night when invited into the night enclosure area, each chimpanzee received two large fleece blankets and an assortment of enrichment items similar in composition to the daytime enrichment. Each day was also given a theme which allowed for caregivers to be creative in their enrichment choices.

Multiple days a week the chimpanzees received some type of forage or food puzzle. This included buckets of tea outside rooms with access to hoses or tubes, requiring tools to be used to acquire the liquid. Bundles of nuts and seeds as well as sticks were attached outside the enclosures, requiring tools as well. Frequently, the chimpanzees received frozen food or drinks.

Fauna Foundation

Fauna Foundation is a chimpanzee sanctuary for chimpanzees with varying backgrounds including former pet, ex-entertainment, retired biomedical, and ex-zoo chimpanzees. When Tatu and Loulis arrived on August 28, 2013, there were five adult female chimpanzees aged 26 to 46 years and five adult males aged 25 to 40 years. The biographical information for the chimpanzees appears in Table 1. During condition two of the study, Tatu and Loulis lived with Sue Ellen and Spock as a group of four.

Fauna Foundation is a 1,115 m^2 facility that consists of six front rooms, two large playrooms, and three smaller areas. There were multiple skywalks (213 m) and three separate islands (0.81 ha) surrounded by electric fencing. The chimpanzees lived in subgroups that occupied different areas throughout the building. Twice a week, the

subgroups were shifted between areas for cleaning. Some individuals shifted between compatible subgroups to form new groupings.

The fluidity among the chimpanzee groups at the Fauna Foundation allowed for new opportunities for contact with social partners. The facility and subgrouping allowed for Tatu and Loulis to have visual barriers to other chimpanzees as well as minimal contact between mesh barriers. These barriers allowed for Tatu and Loulis to build new relationships with other chimpanzees while maintaining safety and allowed staff to assess potential partners for future introductions.

At the Fauna Foundation the chimpanzees received six meals (approximately one cup or less) and a variety of healthy drinks throughout the day. There was always an alternative for a cooked meal. If a chimpanzee chose not to eat their meal when initially offered, it was repeatedly offered throughout the remainder of the day. The chimpanzees at Fauna had access to green vegetables 24-hours a day.

Environmental enrichment was provided at the Fauna Foundation. During the two weekly cleaning days in which the larger enclosures were emptied and cleaned with soap and pressure washed, the chimpanzees' larger areas were filled with enrichment such as toys, magazines, brushes, combs, tubes, buckets, and paper materials. Additionally, chimpanzees received a variety of nesting materials such as sheets, fleece blankets, comforters, and sleeping bags. Only front rooms were cleaned during non-cleaning days. The front rooms consisted of six smaller rooms and two smaller areas. Similar to cleaning days, caregivers enriched the front rooms with food puzzles and foraging materials. Both non-cleaning days and cleaning days had an enrichment theme. Caregivers chose their

Table 1

Biographical Information for the Chimpanzees

Name	Birth & Death Date	Sex	Birth Location	Rearing Condition
Binky	04/10/1989	M	LEMSIP*, NY	Biomedical Lab
Chance	09/13/1983	F	LEMSIP*, NY	Biomedical Lab
Jethro	08/23/1989	M	LEMSIP*, NY	Biomedical Lab
Loulis	05/10/1978	M	Yerkes Regional Primate Research Center, GA	Chimpanzee reared
Maya	07/8/1977	F	Institute for Primate Studies, OK	Cross-fostered/Zoo
Petra	02/24/1988	F	LEMSIP*, NY	Biomedical Lab
Rachel	11/30/1982	F	Institute for Primate Studies, OK	Human home/biomedical lab
Regis	12/28/1988	M	LEMSIP*, NY	Biomedical Lab
Spock	02/9/1976-12/4/2017	M	Institute for Primate Studies, OK	Cross-fostered/Zoo
Sue Ellen	03/17/1967	F	Unknown	Entertainment/ biomedical lab
Tatu	12/30/1975	F	Institute for Primate Studies, OK	Cross-fostered
Toby	05/1/1977-10/16/2017	M	Unknown	Zoo
Yoko	04/7/1974-01/30/2014	M	Unknown	Circus/Biomedical Lab

**Note*: LEMSIP is an abbreviation for the Laboratory for Experimental Medicine and Surgery in Primates.

enrichment items based on the theme for the day. During non-cleaning days chimpanzees always had access to their respective areas depending on subgroup composition.

Video Follows at the CHCI

Video follow at the CHCI occurred twice per year, during fall and spring. Videographers recorded the chimpanzees when they were in the two large playrooms and the outdoor area. A focal chimpanzee was selected in random order without replacement. Focal chimpanzees were recorded for 15 consecutive min. The videographers were graduate students and trained interns at the CHCI. This study used video recorded in Fall 2012 and Spring 2013. For both Fall 2012 and Spring 2013, a total of 10 h of video follow were collected in each condition. During Fall 2012 Dar lived with Tatu and Loulis at the CHCI. During Spring 2013 Dar was deceased and only Tatu and Loulis remained at the CHCI.

Video Follows at the Fauna Foundation

Videotaping occurred seven days a week for a randomly assigned hour between 8:00 a.m. and 4:30 p.m. Data were collected while Tatu and Loulis had access to the Mezzanine and Jeannie's indoor areas and the attached outside areas. Tatu and Loulis did not have access to islands during data collection. The only limitation in access was during cleaning times. Recordings occurred in the specific area Tatu and Loulis had access to that week. Recordings for the Winter 2014 condition occurred from January 5, 2014 to February 19, 2014. A focal chimpanzee was selected in random order without replacement. Focal chimpanzees were recorded for 15 consecutive min, totaling 30 min a

day totaling 17.5 h of data during Winter 2014. The CHCI interns staffed at Fauna Foundation were videographers.

Video Tape Coding

There were a total of 30 h of video that data coders coded total for both Tatu and Loulis combined, 10 h were selected from Fall 2012, 10 h from Spring 2013 and 10 h were randomly selected out of 17 h from Winter 2014. During Winter 2014, 17 h were collected total and 10 were randomly selected for coding.

Data collectors used instantaneous focal sampling at 10 s intervals. Data collectors recorded the focal chimpanzee's behavioral contexts exhibited by the focal chimpanzee at the 10 s mark during 15 min focal samples. Data collectors used operational definitions from Behavioral Taxonomy (see Appendix A) to code the behavioral context. Researchers referred to Appendix B Behavioral hierarchy when multiple contexts occurred at the same time to determine which behavior to code. Behaviors at the top of the hierarchy table were recorded over those at the bottom of the table.

Reliability

Prior to data coding, context coding reliability was obtained using 15 min focal animal video segments. Observers achieved interobserver reliability of at least 85% by independently coding 20% of the data using behaviors found in Appendix A. Data coders were trained in chimpanzee identification for all chimpanzees, including the chimpanzees at the Fauna Foundation via slideshow. Both coders passed the ID test with a score of 100%. The study had two data coders.

Data was collected with the approval from the Institutional Animal Care and Use Committee (IACUC). The protocol number for data collected at the CHCI was A061101. The protocol number for data collected while at the Fauna Foundation was A031402.

Analysis

Loulis had a total of 4,056 and Tatu had a total of 3,564 focal samples between all three conditions. There were differences in sample size, due to errors in video recording. Some sessions were shorter than the 15 min focal time because the focal was out of camera frame or not visible. To make the sample sizes equal in each condition, we selected an equal number of samples from each data set. The condition with the lowest number of data points was the baseline for data points. All instances of bad observation were removed before the elimination of randomized numbers, prior to calculating the baseline for each session.

The observed frequency was too low to calculate a Chi-square Goodness of Fit test for some categories. To increase the frequency, we combined contexts into broader categories. The new categories appear in Table 2.

For the results, we used a Chi-square Goodness of Fit test. Tatu and Loulis had lived in a group of three with Dar for approximately five years before his death in November 2012, so we used the data collected from Fall 2012 as our baseline measurement or expected values for the Chi-square. We used this data because it best described Tatu and Loulis' activity budgets for an extended period of time before the change in group size and is the minimum suggested group size by the NIH.

Table 2

Subcategory and the Contexts in Each Subcategory

Subcategory	Context in each subcategory
Pro-Social	reassurance, affinitive social, play, greet, private sign
Feed	feed
Inactive/Self-directed	inactive, self-groom, stereotypic, sexual
Object	object
Groom	groom
Travel	travel
Agonistic	non-affinitive social, alert, threat, agonistic

CHAPTER IV

RESULTS

Table 3 shows the standardized residuals, frequency and percentages for Tatu in each condition. The distribution of behaviors for Tatu in Spring 2013 was significantly different than the baseline of Fall 2012 (X^2 (6, N = 1188) = 370.01, $p < 0.0001$). The distribution of behaviors in Winter 2014 was significantly different than the baseline (X^2 (6, N = 1188) = 1080.02, $p < 0.0001$).

Table 4 shows the standardized residuals, frequency and percentages for Loulis in each condition. The distribution of behaviors exhibited by Loulis in Spring 2013 was significantly different than the baseline of Fall 2012 (X^2 (6, N = 1352) = 801.72, p <.0001). The distribution of behaviors in Winter 2014 was significantly different than the baseline (X^2 (6, N = 1352) = 425.81, $p < .0001$).

Standardized residuals show the measure of strength between observed and expected values. They show how significant the differences are between each condition compared to the expected values in Fall 2012. A standard residual above or below 2 means the data in that category is a major contributor to the Chi-square value (Northern Illinois University, n.d.). The greatest differences can be found amongst social behavior subcategories. Tables 3 and 4 show the distributions.

For Tatu, the occurrence of pro-social behavior was significantly below the expected value during Spring 2013 (SR = -5.43) and significantly above the expected value in Winter 2014 (SR = 7.16). Grooming during Spring 2013 was below the expected value (SR = -11.18) and significantly above the expected outcome in Winter 2014 (SR =

16.82). Inactive/self-directed behavior was significantly below expected in Winter 2014 (*SR* = -5.48) and significantly above in Spring 2013 (*SR* = 8.31). Non-social behaviors varied across conditions.

For Loulis, pro-social behavior was significantly above the expected value during both Spring 2013 (*SR* = 25.08) and Winter 2014 (*SR* = 16.59). Grooming during Spring 2013 was lower than expected (*SR* = -8.51) and significantly above the expected outcome in Winter 2014 (*SR* = 5.53). Inactive and self-directed behavior was significantly below expected in Winter 2014 (*SR* = -7.26) and significantly above in Spring 2013 (*SR* = 2.92). Non-social behaviors varied across conditions.

For Tatu and Loulis, feeding was significantly below the expected value during Spring 2013. Loulis was significantly above feeding during Winter 2014 (*SR* = 5.13). For Tatu and Loulis, object manipulation decreased during Winter 2014 but varied for both chimpanzees in Spring 2013.

Table 3

Standardized Residuals, Frequency, and Percentage for Tatu During Each Condition

Context categories	Fall 2012 (baseline)			Spring 2013			Winter 2014		
	SR	*f*	Percentage[a] (%)	*SR*	*f*	Percentage[a] (%)	*SR*	*f*	Percentage[a] (%)
Pro-social	-	75	6.3	-5.3	28	2.4	7.16	[3]137	11.5
Feed	-	[2]159	13.4	-9.52	39	3.3	-2.7	125	10.5
Inactive/Self-directed	-	[1]615	51.8	8.31	[1]821	69.1	-5.48	[1]479	40.3
Object	-	116	9.8	6.41	[2]185	15.6	-9.38	15	1.3
Groom	-	[3]125	10.5	-11.18	0	0.0	16.82	[2]313	26.3
Travel	-	90	7.6	-2.64	[3]115	9.7	-5.06	42	3.5
Neutral/Agonistic	-	8	0.7	-2.83	0	0.0	24.4	77	6.5
Total	-	1188			1188			1188	

Note. Bold-faced superscripts in the table indicate the three top ranked behaviors in that condition.

[a]Percentage indicates the distribution of occurrences over total observations for that condition.

Table 4

Standardized Residuals, Frequency, and Percentage for Loulis During Each Condition

Context categories	Fall 2012 (baseline)			Spring 2013			Winter 2014		
	SR	*f*	Percentage[a] (%)	*SR*	*f*	Percentage[a] (%)	*SR*	*f*	Percentage[a] (%)
Pro-social	-	55	4.1	25.08	[2]241	17.8	16.59	[3]178	13.2
Feed	-	[3]115	8.5	-5.13	[3]60	4.4	5.13	170	12.6
Inactive/Self-directed	-	[1]829	61.3	2.92	[1]913	67.5	-7.26	[1]620	45.9
Object	-	39	2.9	-5.12	7	0.5	-5.44	5	0.4
Groom	-	[2]138	10.2	-8.51	38	2.8	5.53	[2]203	15.0
Travel	-	106	7.8	-4.95	55	4.1	-2.14	84	6.2
Neutral/Agonistic	-	70	5.2	-3.82	38	2.8	2.63	92	6.8
Total	-	1352			1352			1352	

Note. Bold-faced superscripts in the table indicate the three top ranked behaviors in that condition.

[a]Percentage indicates the distribution of occurrences over total observations for that condition.

CHAPTER V

DISCUSSION

This study found that when Tatu and Loulis lived in a group of two, there were fewer social behaviors occurring. When Tatu and Loulis moved to a facility with access to more social partners, more social behaviors occurred. The goal of any captive environment is to emulate naturalistic behaviors as much as possible (Pruetz & McGrew, 2001). Although captive environments are not as stimulating as free-living environments, using free-living environments as a reference point may help illuminate ways to provide superior captive care and promote the over all well-being of chimpanzees in captivity.

Free-living chimpanzees spend anywhere from 22.5% to 60% of their time feeding (Boesch & Boesch-Achermann, 2000; Doran, 1997; Matsumoto-Oda et al., 1998; Pruetz & McGrew, 2001; Wrangham, 1977; Yamanashi & Hayashi, 2011); however, prior to Tatu and Loulis' move to the Fauna Foundation, feeding behavior during Spring 2013 was low, at 3.2% and 4.4% respectively. At Fauna Foundation, feeding behaviors increased to 10.5% for Loulis and 12.6% for Tatu, reflecting closer feeding time to their free-living counterparts.

In contrast to the more stringent meal service schedule at the CHCI, chimpanzees at the Fauna Foundation did not have a particular time period to finish a meal, if the meal was not immediately taken the meal was offered throughout the remainder of the day. Although the original timing of the meal was predicable, future offerings were sporadic throughout the remainder of the day. Bloomsmith and Lambeth (1995) found that more unpredictable feeding schedules similar to those at the Fauna Foundation increased

species-typical behavior. With increased availability to food and varying meal service times there was an increase in feeding behaviors.

Object manipulation and traveling decreased at the Fauna Foundation. For this study, if multiple behaviors occurred, researchers referred to a behavioral hierarchy to code the behavior (see Appendix B). The hierarchy places travel and object manipulation lower in the hierarchy than all social behaviors. During Spring 2013 Tatu spent 9.7% of her observations traveling, the second most frequent behavior during that condition; however, at Fauna, traveling decreased to 3.5%, while pro-social behaviors moved to the second most frequented behavior at 11.5%. The overall pattern suggests that time was redistributed to more social behaviors such as grooming and playing rather than object manipulation and traveling. The move allowed for many more social opportunities, which detracted from time using environmental enrichment and added time to more social enrichment.

Threat and agonistic behaviors increased at the Fauna Foundation (Tatu 6.5% and Loulis 3.9%). Chimpanzees are territorial, often participating in patrolling behaviors and aggressive encounters (Schel et al., 2013). Additionally, many chimpanzees in free-living populations injure individuals in neighboring communities infringing on their territory (Goodall, 1986; Watts, Muller, Amsler, Mbabazi, & Mitani, 2006; Wilson, Wallauer, & Pusey, 2004). Typically, males participate in more agonistic and threatening behaviors than females (Goodall, 1986; Schel et al., 2013; Mitani & Watts, 2005), which was reflected in this study. At the Fauna Foundation, Loulis became more vigilant of his surroundings, spending increased time engaged in threat and agonistic behaviors. This

increase in threat behaviors contributed to the overall increase in species-typical behaviors, particularly for a male chimpanzee.

For both Tatu and Loulis, inactive time was the most frequent behavior in both conditions. Inactive time dropped below 50% at Fauna, while during Spring 2013 it was above 65%. Free-living chimpanzees spend up to 50% of their full day resting or sleeping (Pruetz & McGrew, 2001); however, this frequency may not be a relevant reference point for this study. Videan (2006) found that free-living chimpanzees sleep an average of 8.81 h a night, which accounts for nearly a third of total daily resting time. Our data collection hours were performed during daylight and did not account for nighttime resting behavior. Although the goal of captive environments is to allow for as much species-typical behavior as possible, some studies suggest that inactive time may be detrimental to the overall health of captive animals, promoting obesity for example (Bloomsmith & Lambeth, 1995), which can lead to cardiovascular disease (Videan, Fritz, & Murphy, 2007). This suggests that, although inactive time is in fact important to a chimpanzee's life, in captivity it may not be the most beneficial use of time.

With a decrease in resting time at Fauna, social behaviors such as play and grooming moved to the top three most frequent behaviors. When Tatu, Loulis, and their three family members moved to the CHCI from CWU's Psychology building, they showed similar prevalence in behaviors, with 14.1% of time in pro-social behaviors (Jensvold et al., 2001).

Tatu and Loulis increased grooming behaviors at Fauna. During Spring 2013, Tatu spent no time grooming. Loulis had a low percentage at 2.8%. In contrast, at Fauna

grooming was the second most prevalent behavior at 15% (Loulis) and 26.5% (Tatu). Chimpanzees in free-living populations spend 25% of their waking time grooming with others (Goodall, 1986; Kawanka, 1989; Wobber & Hare, 2011). According to Nakamura (2003), social grooming is a common daily occurrence in free-living chimpanzees. With more opportunities for social partners either while in the same enclosure or with neighbors through protected contact, grooming increased and allowed Tatu and Loulis more opportunities to build important bonds with the new members of their community.

While this study recorded grooming behavior, it did not analyze social partner during grooming. Chimpanzees not only groom with other chimpanzees in captivity, but they also groomed with their human caregivers. Humans play a critical role in the daily lives of chimpanzees (Baker, 2004; Funkhouser, Mayhew, & Mulcahy, 2018; Jensvold, 2008; Jensvold, Buckner, & Stadtner, 2010), so it would be beneficial to look at caregiver participation during grooming sessions.

The Council of Councils Working Group on the Use of Chimpanzees in NIH-Supported Research concluded that the ideal captive chimpanzee group size should comprise at least seven individuals conditional on enclosure size (National Institutes of Health, 2013, p.21). Additionally, they suggest that a minimum of three chimpanzees should be socially housed together and that no chimpanzee ever be alone. Although Tatu and Loulis previously never had access to a group larger than five individuals, the move to the Fauna Foundation allowed for their potential group size to increase.

At the time of the study, groups at Fauna typically had a maximum of five chimpanzees of mixed sex and age. Tatu and Loulis spent all of the data collection period

at Fauna with Sue Ellen and Spock in a group of four. On occasion, Spock moved between Tatu and Loulis' group and other groups in the building. Enclosure design allowed for protected access to grooming and social interaction with other chimpanzees in adjacent enclosures through single-mesh caging. Although their actual group size may have only increased by one or two chimpanzees during the study period, the availability for multiple other social partners through protected contact allowed for many more social opportunities. They were not only able to touch other chimpanzees, but observe other group's dynamics and social interactions and participate vocally and visually. Similarly Webb et al. (2016) found that groups with seven or more individuals had higher numbers of friendly interactions. Although our sample size was smaller, we found an increase in social interactions, both protected and in-group, after their move to Fauna that resulted in social patterns similar to those of free-living chimpanzees.

Tatu was 38 years old and Loulis was 36 years old at the time of data collection at Fauna. According to the Lincoln Park Zoo's ChimpDATA (Gazlay, Faust, Ross, & Earnhardt, 2012) the average lifespan for captive male chimpanzees is 31.7 years and for females 38.7 years, putting both Tatu and Loulis in the geriatric category for chimpanzees. With more advanced age, chimpanzees may be more limited physiologically with degenerative diseases like joint disease and bone loss (Baker, 2000). Despite Tatu and Loulis' geriatric classification during the study, we found that the changes in their daily activity budgets showed positive welfare indicators after relocation. With more opportunity for social interaction partners, increased eating opportunities, as well as less

time spent inactive, Tatu and Loulis exhibited a significant increase in species-typical behaviors, contributing to their overall well-being.

Ross, Wagner, Schapiro, Hau and Lukas (2010) found that upon relocation to a new facility within the Lincoln Park Zoo, chimpanzees and gorillas required a minimum of three years to properly acclimate to a new setting. It would be beneficial to all captive chimpanzees, especially those still residing in laboratories, for researchers to study effects of relocation beyond the first few months. Previous studies have used invasive techniques to assess welfare such as blood sample collection. Ross et al. (2010) as well as this study were able to effectively assess welfare with out the use of harmful techniques. Methods from these studies can be used to assess captive chimpanzee welfare will allowing captive chimpanzees to be free from exploitation.

Additionally, future studies should collect longitudinal data to assess activity budgets years after relocation. This might show any changes after the novelty of the environment has passed. Methods used in this study could be used in future research on chimpanzee relocation incorporating a larger sample size. Having a larger, more diverse sample group may allow for researchers to assess relocation techniques and weigh the pros and cons of moving chimpanzees of all sexes and ages.

Sanctuary and zoo managers responsible for relocation of any captive chimpanzees should consider the benefits of a more dynamic group composition and more socially stimulating environment. This study showed that although Tatu and Loulis are both considered geriatric, species-typical behaviors increased in nearly all categories, particularly social behaviors with the move; however, as important as sociality is, that is

not all that should be taken into account. Caregiver knowledge, enrichment opportunities, space to move, and freedom from exploitation are also critical to the well-being of chimpanzees in captivity. Although there may be some risks regarding chimpanzee transfer, specifically for at-risk populations (Schapiro et al. 2012; National Institutes of Health, 2018), this study has shown that with support during all aspects of relocation and careful observation before and after the move, the chimpanzees' overall well-being improved.

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APPENDIXES

APPENDIX A

BEHAVIORAL TAXONOMY

The following is a list of individual behaviors and their abbreviations, categorized (whenever possible) according to the most common context in which they might occur or, alternately, according to their behavior class. Abbreviations are listed first, followed by the behavior name and definition. When a behavior is known to occur in more than one context, it is stated parenthetically at the end of its description. This material was reproduced from the behavioral taxonomy used by McCarthy, Jensvold, and Fouts, 2012.

AS – Affinitive Social
Included in this context are interactions, such as embraces, putting an arm around another chimpanzee, or inspection of the genital swelling of a female, as well as passively Affinitive Social interactions in which a chimpanzee allows another to take an object or solicits an object or contact from another chimpanzee.

Example: Chimpanzee X looks through a magazine. Chimpanzee Y signs HURRY GIMME/ toward the magazine and X gives it to Y.

The absence of aggression is considered passive affinity. It may be difficult to categorize some interactions where one chimpanzee takes an object from another as Affinitive or Nonaffinitive Social. Examine the manner in which the object is taken, arousal level, presence of pilo erect hair, and the facial expressions of the chimpanzee's interacting. If the object is taken without a reaction such as a scream, bark, or hit, it is an Affinitive Social interaction.

AS behaviors include:
Arm Around, Arm Stretch, Bounce, Climb on/off, Cling, Cradle, Dorsal Ride, Embrace, Follow, Gather, Give, Grip, Hold Hands, Inspect, Kidnap, Lean Away, Mount, No Reaction, Present, Present Back, Present for Copulation, Scoop Gesture, Smell, Stroke, Touch.

AG – Agonistic
When a highly aroused chimpanzee makes aggressive physical contact with another. This may include poking, kicking, biting, hitting another individual with a thrown object, or hitting another with an object.

Example: X displays while oriented toward Y. X signs STUPID/ to Y. X then back hand thumps Y. Y in turn bites X. Then Y screams and withdraws from X.

Note the progression of an aggressive interaction from Threat to actual physical contact. An interaction is referred to as Agonistic only after aggressive physical contact has been made.

AG behaviors include:
Back Hand Thump, Bite, Butt, Charge, Dab, Foot Stamp, Hit, Kick, Lift and Slam, Pinch, Punch, Roll, Slap, Stretch Pull, Struggle.

BO-Bad Observation
The focal chimpanzee is visible or partially visible but the observer cannot see the behavior; for example, if the chimp is sitting with his back to the observer or the observer's view is obscured by another chimps or vegetation or structure. BO may also be used if the behaviors are visible but the observer is unable to determine the context.

DISP – Location Displacement
Displacement occurs when a chimpanzee's approach or action causes another chimpanzee to move from a location allowing the approaching chimpanzee to take their place.

Example: X lies down in Tunnel 1, Y climbs into tunnel and signs GO/ to X. X withdraws from Y and Y takes X's place.

Each Displacement interaction is different, so note in the data how the Displacement occurred. Did the displaced chimpanzee push the other chimpanzee, bark, or simply approach to cause the other chimpanzee to move. Use the abbreviation DS where the exact place has been taken.

FEED – Feeding/Eating
Feeding interactions are those which are directly influenced by the presence of food in the chimpanzee's room. These include begging, peering, food sharing, and fighting over food.

Example: X has finished eating and Y is still slowly eating. X approaches Y and signs HUG/ to Y and tries to reach for Y's bowl. Y orients away from X and spoons his food into his mouth more quickly.

An interaction is considered to be in the Feeding context only as long as the chimpanzee's behavior is directed toward the food.

FEED behaviors include: Beg with Hand, Beg with Mouth, Dip, Drink, Eat, Food Present, Food Share, Forage, Peer, Sponge, Wadge.

GREET – Greeting
Greeting is an Affinitive Social interaction that occurs between individuals who meet after a separation. As the two individuals approach each other, they may utter soft or loud

panting sounds; particularly the subordinate, who may bow, crouch, or bob. Sometimes both the dominant and subordinate individuals may grin.

Example: After a separation, X enters the room where Y has been resting. Y jumps up and barks and crouches beside X. X touches Y's head and Y withdraws.

GREET behaviors include:
Arm Stretch, Bend Away, Bipedal Swagger, Bob, Crouch, Dab, Extended Hand, Genital Bounce, Hunch Approach, Head Bob, Hold Hands, Kiss, Open Mouth Kiss, Pat, Wrist Bend.

GR – Grooming
Grooming occurs when one chimpanzee inspects the skin of another chimpanzee by parting the hair with one hand and picking the skin with the free hand or lips. Often this is accompanied by lip smacking or teeth clacking.

Example: X orients his back toward Y and signs GROOM THERE/. Y parts the hair where X has indicated and begins to groom X's back.

GR behaviors include:
Groom, Flinch, Inspect, Reposition, Scratch, Struggle.

IA-Inactive/Resting
General inactivity, such as sitting, standing, resting, reclining (either alert or asleep), looking around, but no actively watching other chimps or humans.

IA Behaviors Include:
Bipedal stance, bottom-up hunch, cling, crouch, dangle, recline, quadrupedal stance, reposition, rub, sit/upright, other.

LP-Lone Play
This occurs when the focal animal engages in solitary play that involves locomotor activity other than simply traveling. Lone play includes playing with body parts, objects, tumbling, rolling, dangling, etc. Anything which causes a chimp to exhibit the playface or laughter can be considered play, but (PL or LP) is not contingent on a PLF.

LP behaviors include:
Dangle play, locomotor play, other.

NAS – Nonaffinitive Social Interaction
Nonaffinitive Social interactions are less outwardly aggressive than Threat and Agonistic interactions. In a Nonaffinitive Social interaction, a chimpanzee may exhibit passive aggression by not allowing another chimpanzee to pass by them in the tunnel.

Example: X approaches cage 1 in the tunnel. Y blocks the entrance to the room and does not move. X signs HURRY/ to Y and attempts to pass.

An anthropomorphic way to think of Nonaffinitive Social interactions is as a rude or impolite behavior. Screaming in the absence of submissive postures and gestures such as crouching and wrist bending may indicate a Nonaffinitive Social interaction.

NAS behaviors include:
Avoid, Body Fling, Escape, Throw, Tunnel Block.

O – Other
This includes any behavior that cannot be described by any of the other primary categories and should be used sparingly.

OBJ-Object Manipulation
This category includes activities involving object use and/or manipulation that do not fall under any social category, or other category such as feeding, grooming, or self-grooming. Behaviors included in OBJ are manual or oral object investigation, tool preparation, tool use, “fecal art”, or nest building. Exploration and investigation (manual, visual, or olfactory) of features in the enclosure should also be included in this category. Must code objects for all OJB behaviors.

OBJ behaviors include:
Extends reach, manual investigation or manipulation of an object or habitat feature, nesting, active oral investigation or manipulation of an object or habitat feature, smelling, tool manufacture, and visual investigation

PL – Play
Various gestures and postures are associated with play. These include the play walk, tickling, wrestling, chase games, and manipulating toys and other objects. Any activity in which a chimpanzee laughs or exhibits the play face or other play behaviors is considered Play.

Example: X signs CHASE/ to Y and approaches Y, who is on the bench. Y laughs and signs HURRY/ and jumps to the floor and runs. X then chases Y.

Highly aroused Play sessions usually contain a certain element of aggression. The presence of the play face and exaggerated play movements like the play walk seem to work as signals that indicate the biting and slapping is "just in fun." Play sessions may end in Agonistic interactions if one chimpanzee responds to a slap, bite or hit as if it were meant aggressively. To determine when play ends and a fight begins, pay close attention to the facial expression of each chimpanzee.

PLAY behaviors include:
Arm Headcover, Butt, Chase, Drag, 1D 2D 3D 4D Dangle, Foot Back, Foot Stamp, Finger Tickle, Finger Wrestle, Flail, Hairhold, Lift and Slam, Play, Play Bite, Play Kick, Play Pinch, Play Slap, Play Walk, Play Wrestle, Poke, Pull On, Roll, Rub, Slide, Spar, Spin, Spit Toward, Struggle, Throw.

PS – Private Sign
When a chimpanzee does not exhibit any socially interactive behaviors three seconds before or after he/she signs, the sign will be considered a Private Sign.

Examples: 1) X hears a strange noise and signs HURRY/ to self when alone. 2) Y looks through a magazine and signs MILK/ while looking at a picture of someone drinking milk.

REAS – Reassurance
Reassurance occurs when one chimpanzee calms another with a single touch, repeated touching or by physical closeness. The individual seeking Reassurance may whimper, beckon, crouch in a submissive posture, or offer a pronated wrist. The individual doing the reassuring may pat, embrace, kiss, or hold the chimpanzee's hand. It nearly always occurs following a high arousal event.

Example: X hits Y. Y whimpers and approaches Z signing HUG/ (soliciting reassurance). Z signs COME HUG/ (offering reassurance), Y approaches, and they hug.

Reassurance also may occur in high arousal Affinitive Social interactions. When collecting data, note what caused the chimpanzee to seek reassurance (e.g., a preceding Nonaffinitive Social interaction, a frightening sound, etc.) Record if, and in what manner, the chimpanzee is reassured.

REAS behaviors include:
Arm Stretch, Bend Away, Bipedal Swagger, Bob, Crouch, Dab, Extended hand, Genital Bounce, Hunch Approach, Head Bob, Hold Hands, Kiss, Open Mouth Kiss, Pat, Wrist Bend.

S – Stereotypic Behaviors
Stereotypical behaviors are repetitive, exaggerated motor patterns such as rocking back and forth (often accompanied by self-clasping); eye or ear poking or pacing, and rock walking. Aberrant behaviors include these, but can also involve self-mutilation (biting or chewing one’s own body parts); pulling out large amounts of hair and occasionally eating it.

S behaviors include:
Poking objects in ears, rocking, self-clasping, self-mutilation, visual inspection, rock-walking.

SG - Self-groom
Self-directed behaviors, which fit the above description of grooming. Sometimes, chimpanzees scratch in the direction of hair growth, then groom that area. This should be coded as SG.

SG behaviors include:
Brush, use of fingers includes nose picking, flinch, hair plucking, mouth, reposition, visual inspection.

SX – Sexual Behavior
Courtship displays, i.e. postures and gestures directed by a male toward a female prior to copulation: these may include bipedal swaggering, sitting hunch, shaking branches, glaring and beckoning, which is usually accompanied by digital probing and/or sniffing of the vaginal and/or anal opening. Presenting of hindquarters by a female to solicit mating (here the female will crouch and orient her rump towards the male, often while looking back at him); mounting; pelvic thrusting; copulation; masturbation; and genital manipulation and/or inspection between members of the same or opposite sex. Presenting and mounting should not be coded as SX unless the context is clearly sexual and not an expression of submission, dominance, or excitement.

SX behaviors include:
Courtship display, head nod, masturbation, mounting the hindquarters, present for copulation, copulation, solicitation of sex

TH – Threat
As a Threat, a highly aroused chimpanzee may show any of the following behaviors toward another chimpanzee without the interaction resulting in Agonistic contact: pilo erect hair, aggressive barking or screaming, back hand thumping or kicking on the cage, foot stamping, bipedal or quadrupedal swaggering, flailing branches or other objects on the floor, or throwing objects at the walls.

Example: X slides an upside down bowl across the floor while pilo erect and hoots and turns toward Y. Y withdraws from X. X stops the display.

When aggressive contact occurs the interaction has become Agonistic.

THREAT behaviors include:

Arm Raise, Back Hand Thump, Bipedal Hunch, Bipedal Swagger, Charge, Display, Foot Stamp, Fixed Stare, Flail, Flap, Head Tip, Hit Away, Hunch Approach, Kick, Quadrupedal Hunch, Quadrupedal Swagger, Rake, Slap, Spin, Spit Toward.

TR – Travel
Any locomotion, i.e. quadrupeal or bipedal walking, running, leaping, climbing, brachiating, etc. The chimp must move at least one body length.

TR behaviors include:
Back up, bipedal running, bipedal walk, brachiating, climb, crutch walk, drop, jump, quadrupedal run, quadrupedal walk, reposition, rock walk, slide, sit-up walk, swing

APPENDIX B

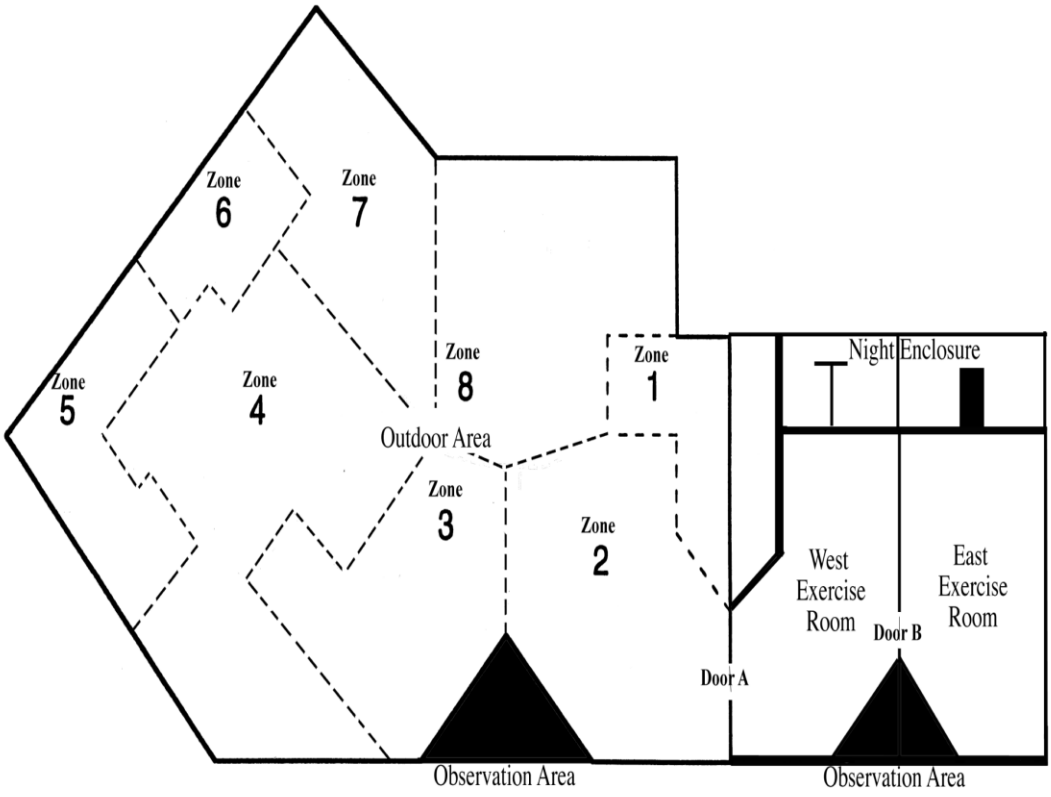
BEHAVIORAL HIERARCHY

This behavioral hierarchy places social behaviors at the top of the hierarchy and non-social behaviors at the bottom. Some behaviors may occur at the same time, behaviors at the top of the table will be recorded over those at the bottom of the table.

Stereotypic Behavior
Agonistic
Threat
Discipline
Nonaffinitive Social
Location Displacement
Affinitive Social
Grooming
Play
Greeting
Reassurance
Feeding/Eating
Private Sign
Object Manipulation
Lone Play
Self-Groom
Travel
Inactive/Resting

APPENDIX C

CHCI BUILDING MAP



APPENDIX D

FAUNA FOUNDATION BUILDING MAP