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Effects of Different Housing Configurations on Captive Chimpanzee (*Pan troglodytes*) Behavior in Holding Area During Construction

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EFFECTS OF DIFFERENT HOUSING CONFIGURATIONS ON CAPTIVE

CHIMPANZEE (*PAN TROGLODYTES*) BEHAVIOR IN

HOLDING AREA DURING CONSTRUCTION

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ABSTRACT

EFFECTS OF DIFFERENT HOUSING CONFIGURATIONS ON CAPTIVE CHIMPANZEE (*PAN TROGLODYTES*) BEHAVIOR IN HOLDING AREA DURING CONSTRUCTION

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In this study, I explored the behaviors, social interactions, and effects different housing configurations on chimpanzees in a zoological environment during a period of construction. I collected noninvasive, observational data at the Oregon Zoo in Portland, Oregon on a small group of chimpanzees, three females and one male, between the ages of 45 and 50 that are split daily into two separate groups of two. I used the focal animal sampling method to record behaviors from an adapted ethogram. I hypothesized that the Oregon Zoo chimpanzees would behave differently depending on which chimpanzee they were housed with. I predicted that the chimpanzees would be housed with one chimpanzee more than the remaining two in the group based on the amount of observation time spent in each housing configuration. I recorded 5,664 total behavioral observations consisting of 26 different behaviors in three different housing configurations. My data showed that there was a large difference in the amount of time each chimpanzee spent in each configuration and that the chimpanzees each have a strong social bond with one other individual.

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CHAPTER I

INTRODUCTION

Primates in captivity often have traumatic life histories, no matter their age or species. Many chimpanzees have ended up in captive facilities because of biomedical laboratory research, entertainment use, or removal from their natural environment as a young individual (Beck, 2010; Knight, 2008). Laboratories, sanctuaries, and zoos have different primary purposes and goals, but strive to provide naturalistic homes to those who live there (Jensvold, 2008; Farley, 2016; Hosey, 2005). The physical environment that surrounds captive chimpanzees plays a role in how they behave, utilize the space, and interact with other individuals (Ross et al., 2010; Ross et al., 2011). Ross and colleagues (2011) found that space selectivity by primates in captivity could have major implications for managing groups and designing new enclosures. Few studies have been published on the baseline behaviors in small, aged chimpanzee groups prior to a move to a new enclosure and introduction to a new group of chimpanzees.

Baker (2000) performed a baseline assessment of chimpanzees in a small social group of mixed ages. Baker found that older females were more submissive and showed less locomotion and object manipulation as compared to younger females. Similarly, older chimpanzees of both sexes showed less aggressive behaviors (Baker, 2000). Wild populations often contain individuals of all ages and consist of much larger troops than zoos can provide for (Stumpf, 2011; Stanford, 2018; Goodall, 1986). The importance of understanding these interactions and spatial use in chimpanzees influences their welfare and quality of life (Ross et al., 2011; Baker, 2000). Baker suggests that group size and composition and introduction procedures should be based on the needs of the older individuals and how they interact with their social partners. It is critical for caregivers to understand the fundamental aspects of how the animals use their environments in order to increase their individual welfare in captivity (Ross et al., 2011).

Ross and colleagues (2010) state that holding areas are primarily focused on functionality, rather than environmental complexity. At the Oregon Zoo, where my project occurred, the chimpanzee holding area was the orangutan exhibit while the new chimpanzee exhibit was under construction. The orangutan exhibit was a naturalistic enclosure that provided daily opportunities for locomotion, enrichment activities, social bonding, and forages. Although it was not a small, constrained housing area, it was an unfamiliar environment for the chimpanzees during the course of construction. I designed my research using Ross and colleagues' study as a model in comparing ape behavior between two alternating environments. I also built off of Baker's (2000) study as a baseline for collecting data on older chimpanzees living in smaller social groups. I studied a specific group of chimpanzees to further understand the behaviors and social interactions in a holding area prior to the introduction of a new group of chimpanzees and a new enclosure. I hypothesized that the Oregon Zoo chimpanzees would behave differently depending on which housing configuration they were placed in. Based on my hypothesis, I made three predictions. Because of the housing situation and the minor influence the chimpanzees had on where and who they are housed with each day, I predicted that each chimpanzee would be housed with and associate him or herself more with one chimpanzee than the remaining two in the group, based on the amount of observation time spent in each housing configuration. I predicted that Jackson would show a stronger bond toward Chloe, Delilah, or Leah through grooming behavior. I predicted that each chimpanzee would show differences in feeding, inactivity, locomotion, self grooming, and allogrooming behaviors between the three housing configurations.

CHAPTER II

LITERATURE REVIEW

Captive Primates

Captive environments are home to thousands of nonhuman primates (Farley, 2016). Over 1,450 chimpanzees reside in facilities in the United States (Chimpcare, 2016). For decades, chimpanzees have been housed in laboratories for biomedical research with a goal to advance human medical knowledge (Knight, 2008; Farley, 2016). In 2013, the NIH, National Institutes of Health, decided that federally owned and supported chimpanzees would be protected from biomedical research, but some individuals would be retained to support certain research projects (Collins, 2015). Following the NIH decision, in 2016, the U.S. Fish and Wildlife Service released an announcement that would affect all chimpanzees, which included individuals that were privately owned and even those that were previously retained for certain projects (Collins, 2015). These decisions placed chimpanzees in a stage of retirement, meaning that the captive population of research chimpanzees would be relocated to sanctuaries or zoos if and when there would be space for them (Collins, 2015). While the majority of chimpanzees in the past have been housed in captivity to be used for biomedical research, Beck (2010) notes that chimpanzees are also kept in captivity for breeding, entertainment use, and housing as pets. Many individuals in captivity have traumatic histories because they are often removed from the wild as an infant or a juvenile as a result of the capture or the death of their mother (Beck, 2010). Most captive settings and institutions naturalize their enclosures in an effort to replicate a wild environment as much as possible (Braverman, 2013; AZA, 2010). Sanctuary settings have a primary purpose of allowing chimpanzees to engage in species-typical behaviors and recover from past experiences, whereas zoological settings have goals grounded in public education, tourism, and research (Beck, 2010; Farley, 2016; Jensvold, 2008). Nonhuman primates in captivity are completely dependent on human caregivers for survival as they are confined to small areas, compared to their natural home ranges (Braverman, 2013). Enrichment is a required component of accredited captive facilities to promote species-typical behaviors and enhance the psychological well being of animals (Bloomsmith & Else, 2005). Chimpanzees use objects as tools in captivity to represent tools they would otherwise create or find in the wild (Humle & Fragaszy, 2011). Zoos and sanctuaries are important supports for conservation and sustaining primates in captivity because wild populations are continually decreasing (Braverman, 2013).

Chimpanzees in captivity are frequently exposed to humans as caregivers and visitors on a daily basis. Visitor presence, noise levels, and crowd size and density are factors that can affect the behavior of a captive individual (Davey & Henzi, 2004; Davey, 2005; Hosey, 2000; Quadros et al., 2014). Large crowds can cause stress and a decrease in species-typical behaviors such as foraging, playing, and grooming in chimpanzees (Fernandez et al., 2009; Hosey, 2005). Although there are individual differences, Birkett and Newton-Fisher (2011) concluded that abnormal behavior is common in captive chimpanzee populations and may indicate stresses associated with captive living. A change in an animal’s behavior or physiological responses can be a sign of poor animal welfare (Quadros et al., 2014; Hosey, 2000; Morgan & Tromborg, 2007). Though research on visitor effects has resulted in conclusions of negative behaviors (Quadros et al., 2014), visitors can also serve as a form of enrichment for animals in captivity

(Morgan & Tromborg, 2007; Hosey, 2000). Zoo tourism can also be beneficial to animals by providing informative experiences for the visitors with goals to further educate them on animal welfare and conservation (Farley, 2016; Morgan & Tromborg, 2007; Hosey, 2005; Fernandez et al., 2009).

Captive Primate Welfare

Animal welfare includes an animal's psychological and physical well being and how the individual interacts with its environment (Hosey, 2000; Perlman et al., 2010; Broom, 1986). Individual differences have an impact on animal welfare, and we cannot judge an animal's welfare as poor from a single behavior or indicator (Broom, 1986). It is difficult to assess welfare and the internal states of animals, but self-directed behaviors and abnormal behaviors are indicators we can use to evaluate welfare (Herrelko et al., 2015; Hosey, 2005). Self-directed behaviors can include scratching and hitting while some abnormal behaviors consist of regurgitation and reingestion (Herrelko et al., 2015). Broom notes that to assess welfare, it is important to understand individual behavior as well as how the individual interacts in his or her group. Indications of poor animal welfare include lack of responsiveness and excess abnormal behaviors (Broom, 1986). Understanding the complex chimpanzee abilities is important for improving their lives in captivity (Perlman et al., 2010). Chimpanzees are restricted in captive environments and are unable to travel their average daily range, obtain food through arboreal foraging, and live in large groups (Farley, 2016; Stumpf, 2011). A lack of natural behaviors has impacts on an individual's overall well being (Farley, 2016). Morgan and Tromborg (2007) confirm that captivity introduces factors that are not present in the wild such as continuous proximity to and interaction with humans.

There are a variety of coping mechanisms that captive primates use to combat visitor stress including moving out of sight or acting aggressive more often (Farley, 2016; Herrelko et al., 2015). In zoological settings, abnormal behaviors recorded in previous research include eating feces, drinking urine, pacing, and overgrooming (Birkett & Newton-Fisher, 2011; Farley, 2016; Hosey, 2000). Although chimpanzees engage in play behavior often, Stanford (2018) suggests that it is not a critical component of animal well being. Visitor behavior can influence how primates use their space as they can shift themselves in and out of proximity of the people within their enclosures (Bonnie et al., 2016).

A factor in determining animal welfare is how individuals in captivity utilize their environments (Ross et al., 2010). Stress and fight or flight responses can occur more often when primates are housed in artificial habitats that restrict movement and reduce feeding opportunities (Morgan & Tromborg, 2007). Captive settings should replicate wild environments by containing naturalistic and enriched enclosures (Ross et al., 2011; Hosey, 2000; AZA, 2010). Chimpanzees in captivity are provided with enrichment materials or objects to encourage species-typical behaviors that represent what they would use in the wild (Stanford, 2018). Perlman and colleagues (2010) state that chimpanzee welfare can improve by encouraging captive individuals to think critically through enrichment and problem-solving behaviors.

Captive Primate Enclosure Use

Apes are sensitive to detailed characteristics of their captive home (Ross et al., 2010) and show location preferences within their environment (Ross et al., 2011). The configuration of enclosures can influence social interactions (Ross et al., 2010). Even if individuals do not utilize the availability of multiple enclosures entirely, the opportunity to choose is an important aspect of their environment and a factor in increasing captive animal welfare (Ross et al., 2011; Ross et al., 2010; Herrelko et al., 2015; Perlman et al., 2010; Hosey, 2000). Choice allows chimpanzees to escape from humans by providing visual barriers and a sense of security (Herrelko et al., 2015; Broom, 1986).

The physical environments of primates in captivity play an important role in their behaviors (Ross et al., 2011; Ross et al., 2010; Fuentes et al., 2015; Herrelko et al., 2015; Bloomsmith et al., 1998). Understanding how captive primates utilize their space is fundamental in maximizing animal welfare, managing groups, and providing enrichment options (Ross et al., 2011). Primates make selective use of their living spaces in captivity by choosing where they spend their time (Ross et al., 2011). They may shift locations in captivity due to preference, daily routines, or human influence (Bloomsmith et al., 1998). Individual differences for how and where chimpanzees spend their time in captivity could arise because of their backgrounds and upbringing (Ross et al., 2011; Ross et al., 2010; Fuentes et al., 2015). Inter-facility differences can affect chimpanzee space use regarding enrichment structures, enclosure characteristics, and differences in group composition (Ross et al., 2011). The likelihood of social conflict increases in smaller areas (Ross et al., 2010; Herrelko et al., 2015). Although previous literature states that more space in captivity improves animal welfare (Paulk et al., 1977), enclosure size may not be the critical factor (Ross et al., 2011). Researchers have concluded that more accessible areas and functional enrichment within enclosures are important elements for decreasing negative welfare (Herrelko et al., 2015). Zoological institutions typically have more than one area, indoor and outdoor, that primates spend their time in (Ross et al., 2011).

Holding areas or indoor enclosures are smaller in size, more structured, and more controlled, which may increase abnormal behavior and decrease species-typical behavior (Ross et al., 2010; Ross et al., 2010). Ross and colleagues (2010) studied chimpanzee and gorilla behaviors when alternating from holding areas to their usual exhibit and found that *Gorilla beringei graueri* showed an increase in species-typical behaviors in the exhibit and higher rates of locomotion while in the holding areas. Chimpanzees were more aggressive in the holding areas and engaged in higher rates of foraging in the exhibit (Ross et al., 2010). The ways chimpanzees use their enclosures can tell us information about their welfare (Ross et al., 2011). The designs and sizes can dictate how often the individuals engage in species-typical behaviors, such as foraging, as well as environmental enrichment use (Ross et al., 2010).

Chimpanzee Taxonomy and Morphology

Chimpanzees are members of the superfamily Hominoidea that includes all apes (Stumpf, 2011). Genetic analyses show that humans are more closely related to chimpanzees and bonobos and are more distant from orangutans and gorillas (Stumpf, 2011). On the great ape phylogenetic tree, the AZA (2010) indicates that gibbons diverged first and orangutans diverged second. Chimpanzees are classified in the family Hominidae, which includes gorillas, chimpanzees, bonobos, and humans (Stumpf, 2011). Further classification places them in the subfamily Homininae, genus *Pan*, and species *Pan troglodytes* (Groves, 2001). There are currently four chimpanzee subspecies recognized by taxonomists that are distributed across different geographical ranges of equatorial Africa (Stumpf, 2011). They include the western chimpanzee (*P.t. verus*), the Nigerian-Cameroon chimpanzee (*P.t. ellioti*), the central chimpanzee (*P.t. troglodytes*), and the eastern chimpanzee (*P.t. schweinfurthii*) (Oates et al., 2009). The Nigerian-Cameroon chimpanzee is the most recent group to diverge, and each subspecies has slightly different demographic histories and population patterns (Mitchell et al., 2015).

Chimpanzees have slow life histories and can live to be an estimated 40-55 years old in the wild (Harvey et al., 1987; Stumpf, 2011). Compared to gorillas and orangutans, chimpanzees have a mild degree of sexual dimorphism, with female chimpanzees weighing between 32-47kg and males weighing between 40-60kg (Cawthon Lang, 2006; AZA, 2010). Most chimpanzees are born with unique facial patterns that change as they grow into adulthood (Stumpf, 2011). Their faces, hands, and feet have light pink colorations at birth that darken as they age (AZA, 2010). Males and females have dark brown to black hair, large canines, and thick brow ridges (AZA, 2010). The genera *Pongo, Gorilla,* and *Pan* are quadrupedal knuckle-walkers with arboreal adaptations including opposable toes and thumbs as well as high wrist mobility (Stumpf, 2011; Ogihara et al., 2005). The hind- and forelimbs of chimpanzees are adapted for both arboreal and terrestrial locomotion (Ogihara et al., 2005). Though it is uncommon, chimpanzees have the ability walk bipedally (Ogihara et al., 2005). Holowka and colleagues (2017) speculate that although chimpanzees exhibit a degree of arboreal locomotion while foraging and sleeping, they are terrestrial travelers throughout the day.

Chimpanzee Habitat and Range

Chimpanzees have a fragmented and limited distribution in Africa (Lonsdorf, 2010; Goodall, 1971). They are distributed across equatorial Africa, primarily in West and Central Africa, in a diverse range of habitats (Stumpf, 2011). Some chimpanzee populations live sympatrically with western lowland gorillas (*Gorilla beringei graueri*)

(Yamagiwa & Basabose, 2006). They can occupy altitudes that can reach up to 3,000 m above sea level in different biomes or ecosystems (Stumpf, 2011). In addition to tropical rainforests, chimpanzees also inhabit woodland biomes, seasonal forests, gallery forests, and bamboo forests (Goodall, 1971; Stanford, 2018). Chimpanzees have a large home range compared to other apes, and range sizes vary across groups and locations (Stumpf, 2011). The central chimpanzee (*Pan troglodytes troglodytes*) has the smallest recorded range size that varies from 7-10 km^2 (Goodall, 1986), and the eastern chimpanzee (*Pan troglodytes schweinfurthii*) has the largest recorded range size of over 50km^2 (Herbinger et al., 2001; Stanford, 2018). The western chimpanzee (*Pan troglodytes verus*) range size lies in the middle at 16-30 km^2 (Herbinger et al., 2001). The variation in home range size is a result of different factors that are unique to the locations of the groups (Stumpf, 2011). Chimpanzee density, food scarcity, and the number of males in a group can influence a lengthened day range and a larger home range (Stanford, 2018; Lehmann & Boesch, 2003). Home range sizes are dependent on food availability: chimpanzees in dry savannas can occupy over 250km^2, and chimpanzees in tropical forests at lower altitudes only occupy 20-40km^2 (Yamagiwa & Basabose, 2006).

Chimpanzee Behavior

The environment of a wild chimpanzee is diverse and complex, which requires individuals to use their intricate cognitive abilities for problem solving, decision making, and reasoning (Farley, 2016; Goodall, 1971; Goodall, 1986; Lonsdorf, 2010; Tomasello & Call, 2010; Wrangham, 2010; Humle & Fragaszy, 2011). Previous studies on apes have concluded that chimpanzees are among a population that can recognize him- or herself in a mirror; a level of self-awareness and complex cognition that most other primates cannot reach (de Waal, 2005). Because of their intellectual and cognitive complexity, they are able to use a diverse range of tools in order to extract fruits and nuts, fish for termites, and create nests for sleeping (Goodall, 1971; Goodall, 1986; Goodall, 1990; Humle & Fragaszy, 2011; Stanford, 2018; Sanz & Morgan, 2010; Koops et al., 2013; Braccini et al., 2010; Lonsdorf, 2010; Hopkins et al., 2010). Tool use allows them to expand their ecological niche and gain access to nutrient-dense foods (Humle & Fragaszy, 2011). Wild chimpanzees manipulate twigs, rocks, leaves, and grass to create tools (Stanford, 2018; Goodall, 1971; Goodall, 1990; de Waal, 2005).

The complex social networks of chimpanzees initiate diverse behaviors between individuals and groups (Tomasello & Call, 2010). In general, Sussman and Garber (2011) suggest that when conflict occurs, aggressive behaviors are likely to follow. In the wild, competition for resources and fertile females can result in lethal aggression within or between chimpanzee groups (Stumpf, 2011; Arnold et al., 2011). Different communities compete over territory and are protective of geographical areas (Stumpf, 2011). Males are the more socially dominant sex, but females engage in aggression over resources and in defense of their offspring (Stumpf, 2011). Reconciliation is a mechanism used by chimpanzees to preserve relationships and reduce stress (de Waal, 2005; Arnold et al., 2011; Wittig, 2010). Reconciliation has been observed in captive and wild chimpanzees as well as in other primate species (de Waal, 2005; Arnold et al., 2011). Although reconciliation rates differ among communities, Wittig found that an estimated 17% of aggressive interactions in wild populations were reconciled afterward. Fuentes and colleagues (2002) found individual differences between a small group of chimpanzees when studying conflict and post-conflict behaviors. Researchers observed a range of behaviors and concluded that reconciliation is important for conflict negotiations in chimpanzee groups with few individuals (Fuentes et al., 2002). Grooming is an affiliative behavior that can indicate reassurance as well as promote group cohesion (Stumpf, 2011; Stanford, 2018). Prosocial behaviors illustrate the rich social environment chimpanzees live in and their complex level of cooperative interaction (Brosnan, 2010). Social interactions like play are behaviors that are often misidentified as aggression because of the use of intense movements, facial expressions, and gestures (Sussman & Garber, 2010; Stanford, 2018).

Nonhuman primates use a variety of signals and modalities, including visual, auditory, olfactory, and tactile senses to relay and receive information about their physical and social environment (Goodall, 1971; Gouzoules & Gouzoules, 2011; Slocombe & Zuberbüler, 2010; Hopkins et al., 2010). Chimpanzees can express their aggression or dominance through piloerection, meaning that their body hair stands upright (Stanford, 2018; Goodall, 1971; Goodall, 1986). Facial expressions are nonverbal signals and the primary mode of visual communication that inform group members about individual emotions (Parr, 2010; Andrew, 1963). Each distinct expression conveys what the individual is feeling (Parr, 2010; Gouzoules & Gouzoules, 2011; Parr, 2010). Play faces typically occur in affiliative, or non-aggressive, contexts (Goodall, 1971; Stanford, 2018; Waller et al., 2007; Andrew, 1963), and pouts often signal distress. Some expressions, such as a grin, can have different meanings depending on how the chimpanzee positions his or her jaw by covering the teeth with the lips or leaving the teeth exposed (Goodall, 1971; Gouzoules & Gouzoules, 2011; Parr, 2010; Hopkins et al., 2010). Baring of the upper and/or lower teeth often indicates fearful or extremely excited emotions (Goodall, 1971; Stanford, 2018; Waller et al., 2007). Nonverbal gestures are more frequently used in captivity compared to vocalizations, perhaps because of the close proximity between individuals in enclosures (Slocombe & Zuberbüler, 2010). Hobaiter and Byrne (2014) found evidence of intentional and goal-oriented gestures in studies of captive groups of chimpanzees (Tomasello & Call, 2010). Gestures can be used in a variety of social situations including reproduction, reconciliation, or during feeding times (Hobaiter & Byrne, 2014; Arnold et al., 2011).

Vocalizations are the most prominent type of communication observed across primate species (Gouzoules & Gouzoules, 2011; Slocombe & Zuberbüler, 2010; Stumpf, 2011), and are a key factor in the chimpanzee lifestyle (Stanford, 2018). Pant hoots are common chimpanzee vocalizations that groups and individuals use to convey information about displays, food, and other groups (Stanford, 2018; Goodall, 1971; Slocombe & Zuberbüler, 2010). Barking occurs when an individual is in a situation of social excitement (Slocombe & Zuberbüler, 2010; Goodall, 1971). Grunts are difficult for human observers to understand because of the different types that differ in sound, length, pitch, intensity, and rhythm (Slocombe & Zuberbüler, 2010; Parr, 2010; Andrew, 1963). All individuals use food grunts during feeding times, while subordinates use pant grunts when approaching dominant individuals (Slocombe & Zuberbüler, 2010; Goodall, 1971). In a study at the Budongo Forest Reserve in Uganda, Slocombe and Zuberbüler concluded that cycling females vocalized the most in response to group settings where males exhibited copulation solicitation and aggression. Chimpanzees also use alarm calls in response to the potential sight of predators (Goodall, 1971; Goodall 1990; Stanford, 2018). Depending on the type of predator, different alarm calls may be used (Hobaiter &

Bryne, 2014). Chimpanzee alarm calls consist of a “wraa” bark as an intense response to danger or disturbances (Stanford, 2018; Goodall, 1971; Slocombe & Zuberbüler, 2010).

Chimpanzees build nests to sleep in at night that provide shelter, predator protection, and comfort (Stanford, 2018). They are typically constructed in the treetops, but are also seen near the ground or on the ground (Stanford, 2018; Stumpf, 2011). Chimpanzees sleep alone unless a mother has her infant. Researchers can therefore use nests to estimate the number of individuals in the forest at research sites (Stanford, 2018; Goodall, 1971; Goodall, 1990).

Chimpanzee Diet

Fruit is the main source of food for chimpanzees as it makes up 64% of their diet (Stumpf, 2011; Stanford, 2018). Though they are highly frugivorous, they will also eat a range of plant species and lower-quality foods when their preferred food is scarce (Stumpf, 2011; Lambert, 2011; Goodall, 1971). Foraging and consumption rates of fruit are higher during the dry season when preferred fruits are abundant (Yamagiwa & Basabose, 2006). In times of fruit scarcity, chimpanzees will feed on bees with honey (Yamagiwa & Basabose, 2006), flowers, and seeds (Stumpf, 2011; Goodall, 1971). Other fallback foods include terrestrial herbaceous vegetation (THV) and bark (Yamagiwa & Basabose, 2006). Chimpanzees spend most of their time eating and nesting in the forest canopy (Stanford, 2018). They obtain nutrient-dense foods through arboreal foraging (Goodall, 1971; Stanford, 2018) and hunting in groups for other mammals. The chimpanzee diet is 8-10% animal protein and 1-3% mammalian flesh (Stumpf, 2011). Red colobus monkeys are the preferred prey at many chimpanzee sites (Goodall, 1986; Stumpf, 2011; Stanford, 2018; de Waal, 2005), but they will also hunt non-primate species such as bushbucks and bushpigs (Goodall, 1971). Chimpanzees engage in cooperative hunting, which is a strategy that allows individuals to work together from the forest floor and the canopy to trap their prey (Sanz & Morgan, 2010). They are more effective and successful at capturing prey when males lead the hunts (Stanford, 2018). Females' reproductive cycles, food availability, and group composition influence the frequency of hunting behaviors in the troop overall (Stanford, 2018; Stumpf, 2011).

Chimpanzee Social Organization

Chimpanzee communities consist of multimale-multifemale and fission-fusion societies (Stumpf, 2011; Yamagiwa & Basabose, 2006; Stanford, 2018; Goodall, 1986; Lonsdorf, 2010; de Waal, 2005). The two biggest factors predicting size and cohesiveness of a chimpanzee society are access to food and reproductive females (Stanford, 2018). Males are philopatric, and females disperse from their natal groups after they reach sexual maturity, which decreases inbreeding and maintains genetic diversity (Stanford, 2018; Stumpf, 2011; AZA, 2010). Chimpanzees are a highly territorial species even though they live in fission-fusion societies (Herbinger et al. 2001; Yamagiwa & Basabose, 2006). Territories and mates are usually patrolled and defended the males of the group (Herbinger et al., 2001).

Chimpanzee Social Structure

Chimpanzees are socially male dominant (Goodall, 1971; Goodall, 1990) and live in complex hierarchical communities with group sizes that can range from 15-20 to 150 individuals (Watts, 2002; Stumpf, 2011; Stanford, 2018; Lonsdorf, 2010; Goodall, 1986). Males show strong coalitionary bonds with other males as well as mate guarding in social relationships (AZA, 2010; Stumpf, 2011). Females can influence their adult sons' dominance rank by keeping ties with them after they disperse (Berman, 2011; Goodall, 1986). Living in groups allows chimpanzees to form alliances, fight off predators, and engage in cooperative hunting as a unit (Sussman & Garber, 2011).

Early evidence of kinship importance, the basis for strong social bonds within communities, was found when researchers recognized relatedness in social interactions as a central feature of social group structure (Stanford, 2018). Stanford suggests that the fission-fusion nature of wild chimpanzee groups would result in a more prevalent kinship presence between males of a group, while females of a group may not be relatives.

Chimpanzee Mating System

According to Stanford (2018) and Stumpf (2011), the two general chimpanzee mating strategies are opportunistic mating, where females will mate with multiple males in a short period with little aggression, and consortships, where a male and a female leave the group for days or weeks at a time. Other strategies may include extragroup mating, possessive mating, and coalitionary mate guarding (Stanford, 2018; Stumpf, 2011; Goodall, 1986). Chimpanzees are promiscuous reproducers as they have multiple partners throughout their menstrual cycles (Goodall, 1986; Lonsdorf, 2010; de Waal, 2005). Females choose male mates based on features that include body size, rank or age, canine tooth size, healthy appearance, and behavioral qualities (Stanford, 2018). Males who are near the top of the dominance hierarchy are the individuals who father most of the offspring in a group (Stanford, 2018). Dominant males form consortships with females as a tactic to prevent other males from mating with her (AZA, 2010). Males will often engage in aggression directed towards other males, which could increase or improve their reproductive success and access to food or females (Stumpf, 2011; Herbinger et al., 2001). Stanford indicates that even though female chimpanzees mate often, the pregnancy rate is low because of a given female's declining fertility with advancing age and/or ineffective consortships.

Chimpanzee Reproduction

The social nature of chimpanzees causes competition between group members for resources for survival (Wittiger & Boesch, 2013). Female reproductive success depends on how much food access they have (Wittiger & Boesch, 2013). Reproductive states require more energy than non-reproductive states because of the costs associated with gestation and lactation (Stanford, 2018; Wittiger & Boesch, 2013). When females are in estrus, they have a swelling in the anogenital region that signals to males that they are ready to mate (Stanford, 2018; Stumpf, 2011). A female's first swelling comes around the age of nine years old (AZA, 2010), and the swellings last for about a month (Stumpf, 2011). Copulation calls are also used as a signal to males to indicate that females are sexually active and available to compete over (Stanford, 2018). Females' reproductive cycles affect the whole community because groups contain multiple females and there is no synchronization in each female's swelling cycle (Stanford, 2018).

Females typically reach sexual maturity quicker than males, although in captive settings, studies have shown males fathering offspring as early as six years old (AZA, 2010). Chimpanzees give birth to singletons, but there have been rare reports of twins (Goodall, 1986; Lonsdorf, 2010). The interbirth interval varies across sites, but on average females give birth once every five to six years (Stumpf, 2011; Goodall, 1986). Infanticide is a behavior where males, and in rare cases, females, kill an infant (Stumpf, 2011; de Waal, 2005; Cawthon Lang, 2006). According to Goodall (1986), infanticide can shorten a female's interbirth interval. Infanticide contributes to high rates of infant mortality (de Waal, 2005). Infant chimpanzees depend on their mothers for survival for the first year of their life because of nursing needs and their altricial stage of development (Cawthon Lang, 2006; Lonsdorf, 2010; Stanford, 2018). Young chimpanzees are weaned between four and six years of age (Stumpf, 2011; AZA, 2010; Cawthon Lang, 2006). The slow life histories of chimpanzees constrict their physical abilities until they reach six years of age (Doran, 1997), whereas gorillas (*Gorilla gorilla*) develop quicker in terms of bones, muscles, limbs, and skin (Leigh & Blomquist, 2011).

Chimpanzee Conservation Status

According to the International Union for Conservation of Nature (IUCN) Red List, chimpanzees are considered endangered (Humle et al., 2016). Stumpf (2011) states that the chimpanzee population has declined over 60% in the last 30 years, with an estimated 173,000-300,000 individuals left in the wild across all four subspecies. Human populations are rising and chimpanzee populations declining because of threats like disease transmission, habitat destruction, poaching, bushmeat trade, and the pet trade (Lonsdorf, 2010; Goodall, 1971; Goodall, 1990; Stumpf, 2011). Zoonotic diseases are a cross-species contamination between humans and primates that can be infectious or non-infectious (Strier, 2011). Disease risk is high and more likely when wild primate populations are in closer contact with humans (Lonsdorf, 2010, Strier, 2011).

Nearly 40% of all ape conservation areas in west equatorial Africa lie in a region that is influenced by logging concessions and human impacts (Lonsdorf, 2010; Strier, 2011). Forests are fragmented because of human impact and need for land, farming, logging, or other agricultural needs (Lonsdorf, 2010; Goodall, 1990; Blumstein &

Fernandez-Juricic, 2010). Fragmentation causes isolated populations and disrupted natural processes such as animal dispersal and genetic variation (Strier, 2011; Goodall, 1990). Genetic variation is important for populations because it allows individuals to adapt to the environment through evolution (Strier, 2011). Human demand for resources and disturbance of habitat are the main causes of habitat loss for chimpanzees and other primates (Strier, 2011; Goodall, 1990; Blumstein & Fernandez-Juricic, 2010). Frid and Dill (2002) state that chimpanzees can tolerate high levels of disturbance, but will also detect humans as more of a predator and react accordingly by giving alarm calls or fleeing from an area (Fernandez & Juricic, 2010; Gouzoules & Gouzoules, 2011).

Poachers target adult female chimpanzees for bushmeat because they often carry infants (Strier, 2011, Goodall, 1990). Infant chimpanzees are emotionally and physically reliant on their mothers earlier in life (Goodall, 1986). If the mothers are shot, then their offspring will likely be shot or sold into the pet trade (Lonsdorf, 2010; Beck, 2010). If the infants survive, the possibility of eventual placement in a captive setting is extremely high (Goodall, 1990). In captivity, they are robbed of a natural lifestyle and are forced to be confined in a small environment where they cannot express the full range of natural behaviors such as traveling, foraging, and hunting (Goodall, 1990; Farley, 2016).

With primate conservation being a global concern, many species, including chimpanzees, are protected in national parks (Goodall, 1990), sanctuaries, and at research sites (Strier, 2011). Along with elephants, pandas, and tigers, they are a flagship species with a declining population (Humle et al., 2016). Protection measures allow for more awareness of the species and what humans can do to help prevent extinction (Strier, 2011).

A goal of most captive institutions is to replicate wild environments and behaviors, such as fission-fusion social organizations and the encouragement of foraging behaviors (Baker, 2000; Bloomsmith et al., 1998). This orientation improves the well being of the captive individuals and educates the viewing public by providing them opportunities to observe naturalistic behaviors. As an endangered species, chimpanzee populations are at risk of extinction. With knowledge of chimpanzee behaviors and animal welfare, my study will provide useful information to zoo staff for managing the group composition and understanding individual tendencies in order to make a smooth transition to the new enclosure and safely proceed with the introductions to new group of chimpanzees in the future.

CHAPTER III

METHODS

Study Site and Subjects

I conducted my research at the Oregon Zoo from October 2019 through November 2019. The zoo is open to the public seven days a week from 0930 to either 1600 or 1800, depending on the season. The zoo provides animals with intriguing environments, naturalistic settings, enrichment, and the concept of choice every day in terms of enrichment and forages. Aside from being a home to animals, the zoo serves as a place for humans to understand wildlife, and how to improve the animals' lives. Since 2008, improvements and new exhibits have been created for penguins, condors, and elephants as well as the addition of a veterinary center and an education center. At the time of my study, the chimpanzees were housed in the orangutan exhibit during construction as a holding area with an indoor and outdoor enclosure until the new chimpanzee exhibit is open. I focused my research on the chimpanzees' behaviors and social interactions based on their housing configuration while in the holding area.

Caregivers arrive at the zoo daily between the hours of 0600 and 0700 for feeding, cleaning, and animal shifting procedures. The zoo currently only houses four chimpanzees and they are typically separated into two groups of two between the indoor and outdoor enclosures. For shorter periods of time, they may be separated into a group of three and a solo individual. The chimpanzees are not housed as a group of four in order to prevent intragroup aggression and because of their unique social structure. On rare days, often based on group cohesion, the configurations are changed midday. The configurations are rotated daily and are influenced by where the chimpanzees place themselves in the beginning of the day and who they are in close proximity to. Caregivers ultimately determine the housing configurations behind closed doors in steel caged rooms. This area is out of view to the public and only accessible to the caregivers. The caregivers will open the corresponding automatically operated doors where each group of two chimpanzees is present. According to Julia Walz (Personal communication, May 31, 2019), the current configurations for the indoor and outdoor enclosures are often dependent on Jackson, the only male of the group, and his cooperation with the female that he is paired with for that configuration. The females of the group have been living together for over 40 years, while Jackson was introduced to the group much later. Because of this, his social bonds are not as strong as the core group of females.

I collected data from a group of four adult chimpanzees at the Oregon Zoo. The group includes three females and one male. Chloe is a 50-year-old female who arrived at the zoo when she was 6 years old. She previously lived as a pet and in a circus environment and has become the dominant individual in the current group ("Chimpanzee," n.d.). Delilah, 46 years old, and Leah, 45 years old are biological sisters who were born at the zoo into multimale-multifemale groups. Jackson is 48 years old and was born in the wild, but he was captured at a young age and spent much of his life with humans. He lived in the Jacksonville Zoo and the Oklahoma City Zoo before arriving at the Oregon Zoo in 2013 ("Chimpanzee," n.d.). Perhaps in part to past living circumstances, Jackson has unique social interactions and will be the most difficult to integrate into the new group of chimpanzees in the new chimpanzee exhibit.

Procedures

I collected data in a 6-week period from October 8th, 2019 to November 22nd, 2019 between the hours of 0930 and 1500 5 to 6 days a week. The first 3 days at the beginning of the study, I collected preliminary data to refine my ethogram. I also tested my chimpanzee identification during this time via communication with Oregon Zoo caregivers to establish reliability. I entered my ethogram into the ZooMonitor software on an Apple iPad and proceeded to record chimpanzee behaviors and housing configurations. My ethogram was constructed and adapted from previous published studies. I used the continuous focal animal sampling method (Altmann, 1974) for each of the four chimpanzees. I collected at least four focal samples for each chimpanzee per day and recorded all observed behaviors during each sample. Samples were 10 minutes long with a 2 to 5 minute rest between each sample. I used randomized sequencing schedules to ensure that I acquired equal amounts of data for each individual. Random sequencing allowed for each chimpanzee to be observed throughout each day.

My observations took place from three different public viewing areas. The entire indoor enclosure (Figure 1) was only visible from one viewing area, while parts of the outdoor enclosure, upper and lower, were visible from all three areas (Figure 2 and Figure 3). I shifted between viewing areas based on which enclosure the focal chimpanzee was housed in and whichever area gave me the best line of sight to that individual. Before the start of each sample, I recorded several items of information. This included whom the focal chimpanzee was housed with and the number of consecutive days they remained in that particular configuration, either indoor or outdoor enclosure

Figure 1

Indoor Enclosure View

Figure 2

Outdoor Enclosure (Upper View)

Figure 3

Outdoor Enclosure (Lower View)

access, and weather temperatures. I observed and recorded a total of 26 behaviors (See Appendix A for full ethogram), but I focused on affiliative, locomotion, and feeding behaviors for analysis. For interactive or social behaviors, for example, allogroom, I recorded the actor(s) and recipient(s) for the behavior. A total of five behaviors were analyzed because that is where the bulk of the data came from. With these behaviors, I was able to evenly analyze the behaviors of all four chimpanzees. Other data, such as aggression, was omitted for analysis due to the small amount of observational data.

In addition to recording behaviors, I also recorded construction information. Construction was rarely visible from my observation locations, but I recorded any feelings of vibrations from nearby construction activity. I used a decibel meter to score the sounds of construction. I scored the highest and lowest decibel reading for each sample and noted the peak and low points after each observation day. Since construction activity was a daily operation, there were no observational days without construction to compare how it affected the chimpanzees' behaviors. Due to this schedule, I omitted construction information from my analysis.

Analysis

I used Microsoft Excel and RStudio to test predictions and examine observations. To analyze the data, I set an alpha value (p) at ≤ 0.05. I recorded an overall total of 5,664 behavioral observations within 601 focal samples. I combined horizontal and vertical locomotion into one category called locomotion and also combined two similar, low-activity behaviors, inactive and sleeping/nesting, into one category called inactivity. The five behaviors I used in analysis were feed/forage, locomotion, inactivity, self-groom, and allogroom because I observed the most data on them (Table 1).

Table 1

Chimpanzee Ethogram of Analyzed Behaviors

Behavior	Code	Description	Source
Feed/Forage	F	Individual is handling, manipulating or ingesting food items. Includes foraging through bedding or other materials in search of desired food items	AZA, 2010
Allogroom	AGM	Picking through hair or at skin of another individual and removing debris with hands and/or mouth	Herrelko et al., 2015
Self Groom	SG	Picking through own hair or skin removing debris	Baker, 2000
Locomotion			
Horizontal Locomotion	HL	Individual changes location in horizontal space by walking, running, crawling, etc. The change in location must be greater than one body length	AZA, 2010
Vertical Locomotion	VL	Individual changes location in vertical space by climbing, sliding, jumping, etc. The change in location must be greater than one body length	AZA, 2010
Inactivity			
Sleeping/nesting	SN	Subject is lying on it’s side and/or sleeping	My own
Inactive	I	Subject rests or is motionless	Ross et al., 2010

I used a chi-square test of independence to formally test the prediction that the chimpanzees would associate with one particular chimpanzee more than the other two based on the amount of time they were in each configuration. I ran a second chi-square test of independence on which configuration was in place at the beginning of each day at the start of my observations.

Jackson. I calculated the total amount of time I observed Jackson as the focal animal and compared it to the amount of time he was housed with Chloe, Delilah, and Leah to explore the prediction of which chimpanzee he was housed with the most. I converted the observation times to a percent to further analyze which housing configuration Jackson spent the most time in. The null hypothesis was that all four chimpanzees would spend equal amounts of time in each configuration. I calculated the total amount of time Jackson spent allogrooming and determined what percentage of the time he initiated the behavior in samples where he was the focal animal. I was only able to compare Jackson's grooming behavior between two chimpanzees, as there was no data on the third. Because my data did not meet the assumption of normality to run a t-test, I used a Mann-Whitney U non-parametric alternative to test the prediction that Jackson would show a stronger bond toward Chloe, Leah, or Delilah through grooming behavior.

Because my data did not meet the assumption of normality to run an ANOVA, I used a Kruskal-Wallis non-parametric test to test the prediction that Jackson would show differences in feeding, inactivity, locomotion, self-grooming, and allogrooming behaviors between the three housing configurations. The null hypothesis was that chimpanzees would show no differences in behavior depending on which individual they are housed with. For any behaviors with significant results from the Kruskal-Wallis test, I used a post hoc Nemenyi pairwise multiple comparison test to determine which housing configuration was different from the rest.

Chloe. I calculated the total amount of time I observed Chloe as the focal animal and compared it to the amount of time she was housed with Jackson, Delilah, and Leah to explore the prediction of which chimpanzee she was housed with the most. I converted the observation times to a percent to further analyze which housing configuration Chloe spent the most time in. The null hypothesis was that all four chimpanzees would spend equal amounts of time in each configuration. Due to the spread of data on Chloe, there were only two possible comparisons for grooming. I used a Mann-Whitney U non-parametric test to test her grooming behavior across configurations with that data. In addition to testing differences, I calculated the total amount of time she spent allogrooming and determined what percentage of the time she initiated the behavior in samples where she was the focal animal.

My data did not meet the assumption of normality to run an ANOVA, so I used the non-parametric alternative, Kruskal-Wallis test, to test the prediction that Chloe would show differences in feeding, inactivity, locomotion, self-grooming, and allogrooming behaviors between the three housing configurations. The null hypothesis was that chimpanzees would show no differences in behavior depending on which individual they are housed with.

Delilah. I calculated the total amount of time I observed Delilah as the focal animal and compared it to the amount of time she was housed with Jackson, Chloe, and Leah to explore the prediction of which chimpanzee she was housed with the most. I converted the observation times to a percent to further analyze which housing configuration she was in the most. The null hypothesis was that all four chimpanzees would spend equal amounts of time in each configuration.

Because my data did not meet the assumption of normality to run an ANOVA, I used a Kruskal-Wallis non-parametric test to test the prediction that Delilah would show differences in feeding, inactivity, locomotion, self-grooming, and allogrooming behaviors between the three housing configurations. The null hypothesis was that chimpanzees would show no differences in behavior depending on which individual they are housed with. For any behaviors with significant results from the Kruskal-Wallis test, I used a post hoc Nemenyi Pairwise Multiple Comparison test to determine which housing configuration was different from the rest. There were only two possible comparisons for grooming data on Delilah. I used a Mann-Whitney U non-parametric test to test her grooming behavior across all three configurations. In addition to testing for differences, I calculated the total amount of time she spent allogrooming and determined what percentage of the time she initiated the behavior in samples where she was the focal animal.

Leah. I calculated the total amount of time I observed Leah as the focal animal and compared it to the amount of time she was housed with Jackson, Delilah, and Chloe to explore the prediction of which chimpanzee she was housed with the most. I converted the observation times to a percent to further analyze which housing configuration she was in the most. The null hypothesis was that all four chimpanzees would spend equal amounts of time in each configuration.

Because my data did not meet the assumption of normality to run an ANOVA, I used a Kruskal-Wallis non-parametric test to test the prediction that Leah would show differences in feeding, inactivity, locomotion, self-grooming, and allogrooming behaviors between the three housing configurations. The null hypothesis was that chimpanzees would show no differences in behavior depending on which individual they are housed with. I also calculated the total amount of time Leah spent allogrooming and determined what percentage of the time she initiated the behavior in samples where she was the focal animal.

CHAPTER IV

RESULTS

In 32 days at the Oregon Zoo, I observed behaviors of four adult chimpanzees (three females and one male) in different housing configurations between two enclosures during a period of construction. Chimpanzees were typically separated into groups of two ($N = 32$ days) with one unusual configuration of a three and one split ($N = 3$ half days). Due to the lack of data in the odd split, I only analyzed the housing configurations with two chimpanzees in each group. The three possible configurations consisted of configuration one: Jackson/Chloe and Delilah/Leah, configuration two: Jackson/Delilah and Leah/Chloe, and configuration three: Jackson/Leah and Chloe/Delilah (Table 2). I collected a total of 502 focal samples between the three configurations and feeding/foraging, inactivity, locomotion, self-grooming, and allogrooming behaviors for analysis. There is an approximately equal spread of data of 10-minute focal samples for Jackson ($N = 126$ focal samples), Chloe ($N = 122$), Delilah ($N = 127$), and Leah ($N =$ 127). Within the 502 total focal samples, I recorded 4,000 behavioral observations of the five behaviors. Each behavioral observation consisted of a single behavior with a duration ranging in length from 1 to 599 seconds.

Table 2

Housing Configurations

	Pair 1	**Pair 2**
Configuration 1	Jackson/Chloe	Delilah/Leah
Configuration 2	Jackson/Delilah	Leah/Chloe
Configuration 3	Jackson/Leah	Chloe/Delilah

Reliability

To test intra-observer reliability, I recorded a 10-minute video of Jackson on October 14th, 2019 and scored the video as a sample every other week throughout my study. There were 19 different behavioral observations within the five behaviors in the sample video and I recorded the same sequence of behaviors each time I scored the samples for 100% (19/19) reliability. This ensured that my ethogram was not changing throughout data collection. I also performed three chimpanzee identification checks with the Oregon Zoo caregivers to ensure that I accurately identified the focal animal for each sample. I identified each chimpanzee correctly during each identification check for 100% (4/4) reliability.

Based on the hypothesis that the chimpanzees would behave differently depending on which housing configuration they were placed in, I made the prediction that each chimpanzee would associate themselves with one chimpanzee more than the other two. To further analyze this, I used a chi-square test of independence with alpha set at 0.05 and compared the total durations for each configuration (Figure 4). The results proved significant and supported my prediction ($\chi^2 = 199538$, $p < 0.05$). I ran a second chi-square test of independence on the state of the configurations at the beginning of each day and the results were not significant ($\chi^2 = 4.10$, $p = 0.13$).

Jackson as Focal Animal

To determine whom Jackson was housed with the most, I calculated the total number of observation samples ($N = 126$) with him as the focal animal. He spent 58% of observation time housed with Chloe ($N = 73$), 29% with Delilah ($N = 36$), and 13% with Leah ($N = 17$).

Figure 4

Correlation Plot of Total Durations in Each Configuration

Note: Each row contains durations of the focal animal in each configuration

To test the prediction that Jackson shows a stronger bond toward Chloe, Delilah, or Leah, I compared the total durations of grooming behavior for each configuration. Jackson spent a total of 199.84 minutes allogrooming ($N = 20$ observations) within the 126 focal samples and he initiated the behavior 55% ($N = 109.63$ minutes) of total observation time when he was the focal animal (Table 3). When Jackson was the focal animal, there was no data for Jackson grooming Leah when they were housed together. For the grooming behaviors between Jackson and Chloe ($N = 15$ observations) and Jackson and Delilah ($N = 5$ observations), I used a Mann-Whitney U test with alpha set at 0.05 to test the hypotheses that observations of grooming differed in the two housing conditions. The results showed no significant difference ($W = 42$, $p = 0.74$) and did not support the prediction.

Table 3

Jackson Allogrooming Durations

Configuration	Total time (minutes)	Time Jackson initiated behavior (minutes)	Time mate initiated behavior (minutes)
1 – Chloe	146.20	81.40	64.80
2 – Delilah	17.77	12.20	5.57
3 – Leah	35.87	16.03	19.83

Using a Kruskal-Wallis ANOVA with alpha set to 0.05, I tested the prediction that Jackson would show differences in feeding (N = 156 observations), inactivity (N = 354), locomotion (N = 334), self-grooming (N = 105), and allogrooming (N = 20) behaviors between the three housing configurations. I compared the behaviors by the durations of each behavior in each configuration (Figure 5). There were no significant differences (Table 4) in feeding ($\chi^2 = 0.99$, $p = 0.61$), inactivity ($\chi^2 = 1.09$, $p = 0.58$), or locomotion ($\chi^2 = 1.07$, $p = 0.58$). I found a significant difference in self-grooming behavior ($\chi^2 = 17.51$, $p < 0.05$). However, this set of data contained an outlier. I removed one behavioral observation from a single sample in configuration 1 for self grooming. The Kruskal-Wallis results following the removal of the outlier remained significant ($\chi^2 = 16.51$, $p < 0.05$). To further analyze the difference in self grooming, without the outlier, and determine which configuration was different from the others, I used a post hoc Nemenyi test and found the significant difference between housing configurations one, housed with Chloe, and two, housed with Delilah (Table 5; $p < 0.05$; Figure 6).

Figure 5

Durations of Five Behaviors For Jackson in Configurations 1 (Chloe), 2 (Delilah), and 3 (Leah)

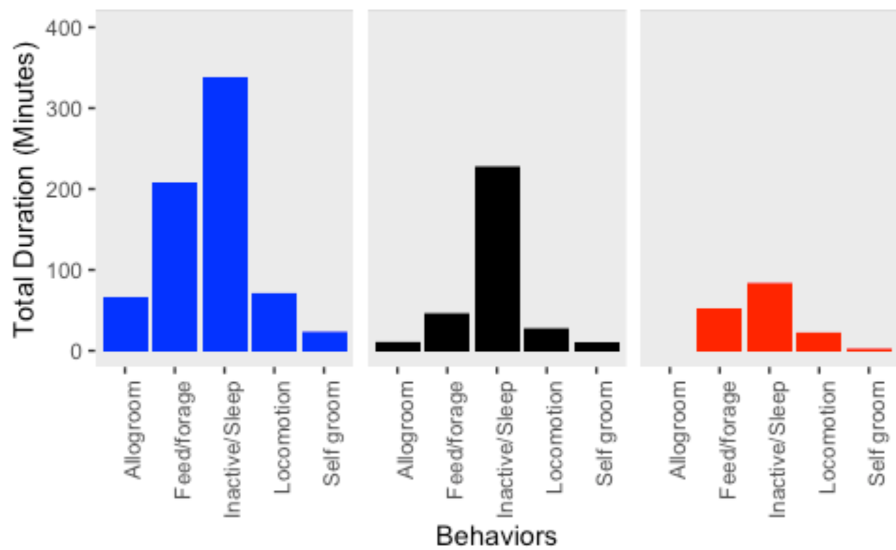


Table 4

Statistical Summary for Jackson's Behaviors in All Housing Configurations

Behavior	df	χ^2	*p*-value
Feed	2	0.98	0.61
Inactivity	2	1.09	0.57
Locomotion	2	1.07	0.58
Self groom	2	16.51	0.00
Allogroom	1	0.15	0.69

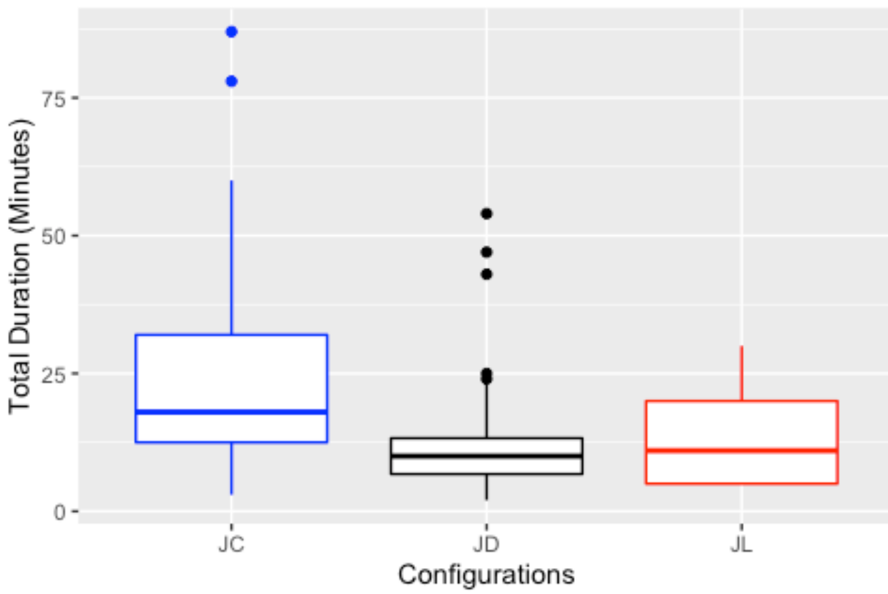
Table 5

Nemenyi Pairwise Multiple Comparison for Jackson Self Grooming

	Configuration 1 - Chloe	Configuration 2 - Delilah
Configuration 2 - Delilah	0.00	
Configuration 3 - Leah	0.16	0.91

Figure 6

Boxplots of Jackson Self Grooming in Configurations 1 (Chloe), 2 (Delilah), and 3 (Leah)



Chloe as Focal Animal

To determine whom Chloe was housed with the most, I calculated the total number of observation samples (N = 122) with her as the focal animal. She spent 57% of observation time housed with Jackson (N = 70 focal samples), 30% with Leah (N = 36), and 13% with Delilah (N = 16).

Chloe spent a total of 206.58 minutes allogrooming (N = 30 observations) within the 122 focal samples and she initiated the behavior 38% (N = 77.82 minutes) of total observation time when she was the focal animal (Table 6). When Chloe was the focal animal, there were no observed grooming behaviors between Chloe and Delilah when they were housed together. I used a Mann-Whitney U with alpha set to 0.05 to test between the groups consisting of grooming with Jackson (N = 20 observations) and Leah (N = 10). There was no significant difference between the two (W = 109.50, p = 0.69).

I used a Kruskal-Wallis ANOVA with alpha set to 0.05 to determine the behavioral differences for feeding (N = 126 observations), inactivity (N = 374), locomotion (N = 287), self-grooming (N = 66), and allogrooming (N = 30) between the three configurations. The results (Table 7) showed no significant differences for feeding ($\chi^2 = 0.35$, $p = 0.84$), inactivity ($\chi^2 = 0.40$, $p = 0.82$), locomotion ($\chi^2 = 0.75$, $p = 0.69$), and self-grooming ($\chi^2 = 1.55$, $p = 0.46$). I compared the behaviors by the durations of each behavior in each configuration (Figure 7).

Table 6

Chloe Allogrooming Durations

Configuration	**Total time (minutes)**	**Time Chloe initiated behavior (minutes)**	**Time mate initiated behavior (minutes)**
1 – Jackson	146.20	64.80	81.40
2 – Leah	60.38	13.02	47.37
3 – Delilah	0	0	0

Table 7

Statistical Summary for Chloe's Behaviors in All Housing Configurations

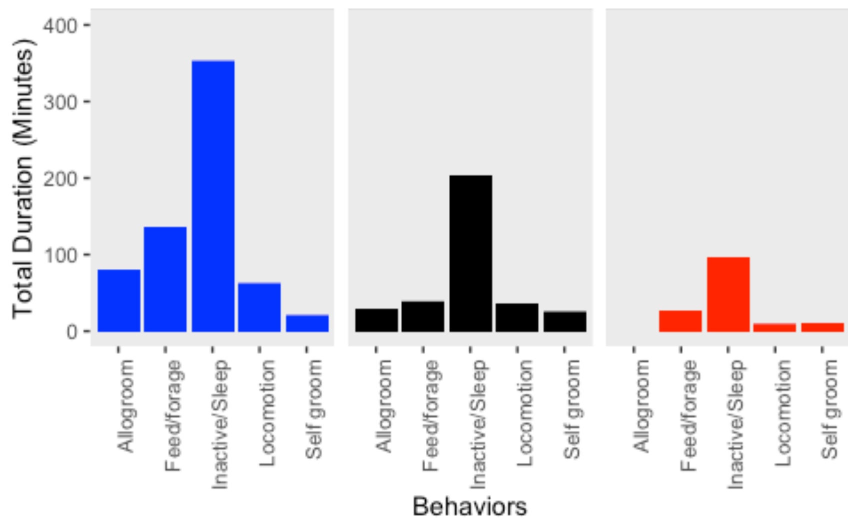
Behavior	**df**	χ^2	***p*-value**
Feed	2	0.35	0.83
Inactivity	2	0.39	0.81
Locomotion	2	0.75	0.68
Self groom	2	1.54	0.46
Allogroom	1	0.17	0.67

Delilah as Focal Animal

To determine whom Delilah was housed with the most, I calculated the total number of observation samples (N = 127) with her as the focal animal. She spent 57% of observation time housed with Leah ($N = 73$ focal samples), 30% with Jackson ($N = 38$), and 13% with Chloe ($N = 17$).

Figure 7

Durations of Five Behaviors for Chloe in Configurations 1 (Jackson), 2 (Leah), and 3 (Delilah)



To test the prediction that Delilah would show differences in behaviors between the three configurations, I used a Kruskal-Wallis ANOVA with alpha set to 0.05. I compared the behaviors by the durations of each behavior in each configuration (Figure 8). I found no significant differences (Table 8) between feeding ($N = 144$ observations) ($\chi^2 = 1.62$, $p = 0.44$), locomotion ($N = 392$) ($\chi^2 = 4.79$, $p = 0.09$), and self-grooming ($N = 34$) ($\chi^2 = 1.63$, $p = 0.44$). The results for inactivity ($N = 470$) showed a significant result ($\chi^2 = 5.80$, $p \leq 0.05$). To further analyze the difference in inactivity and determine which configuration was different from the others, I used a post hoc Nemenyi test and found the largest difference between housing configurations one, housed with Leah, and three, housed with Chloe (Table 9; $p < 0.05$; Figure 9).

Figure 8

Durations of Five Behaviors for Delilah in Configurations 1 (Leah), 2 (Jackson), and 3 (Chloe)

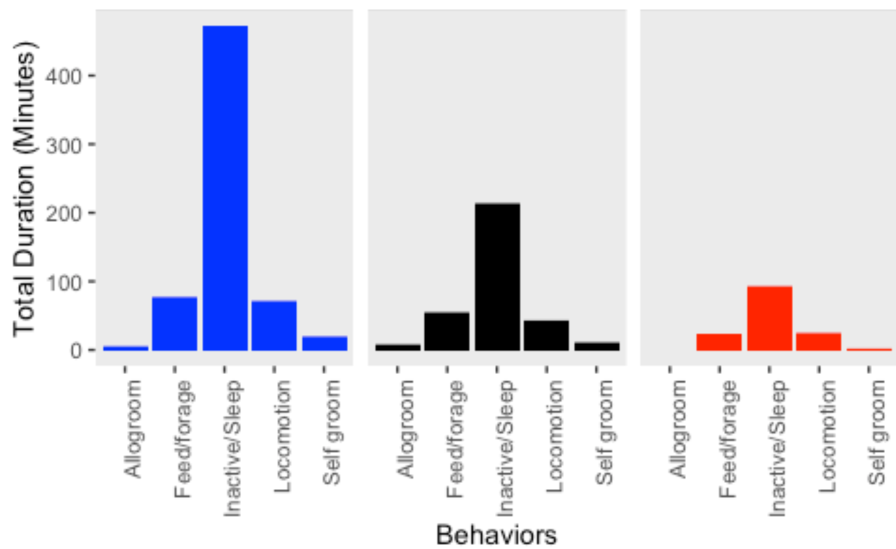


Table 8

Statistical Summary for Delilah's Behaviors in All Housing Configurations

Behavior	**df**	χ^2	***p*-value**
Feed	2	1.62	0.44
Inactivity	2	5.80	0.05
Locomotion	2	4.78	0.09
Self groom	2	1.63	0.44
Allogroom	1	0.02	0.88

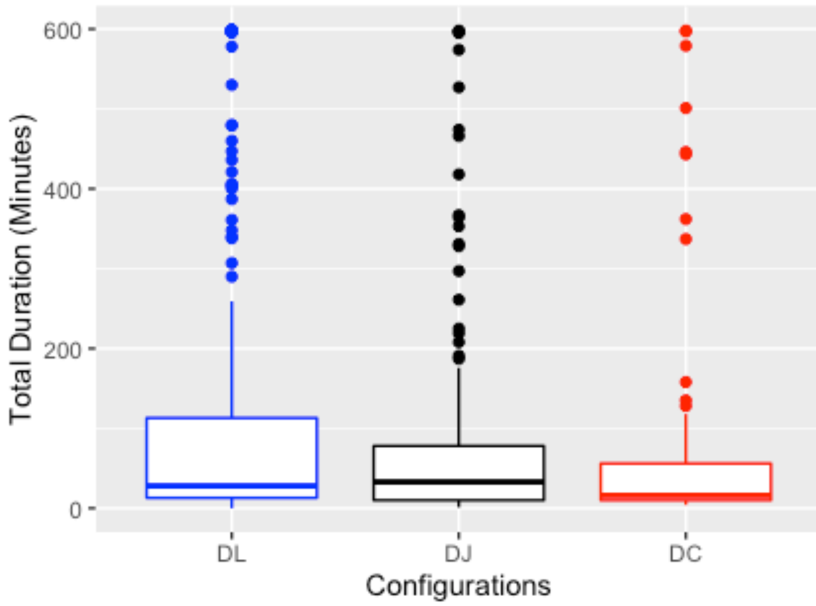
Table 9

Nemenyi Pairwise Multiple Comparison for Delilah for Inactivity

	Configuration 3 - Chloe	**Configuration 2 - Jackson**
Configuration 2 - Jackson	0.48	
Configuration 1 - Leah	0.06	0.35

Figure 9

Boxplots of Delilah's Inactivity in Configurations 1 (Leah), 2 (Jackson), and 3 (Chloe)



Delilah spent a total of 33.04 minutes allogrooming (N = 8 observations) within the 127 focal samples and she initiated the behavior 17% (N = 5.57 minutes) of total observation time when she was the focal animal (Table 10). When Delilah was the focal animal, there were no observations of grooming with Chloe when they were housed together. I compared grooming behaviors with Jackson (N = 5 observations) and Leah (N = 3). The results of a Mann-Whitney U test with alpha set to 0.05 showed no significant difference (W = 8, p = 1) between the two.

Leah as Focal Animal

To determine whom Leah was housed with the most, I calculated the total number of observation samples (N = 127) with her as the focal animal. She spent 57% of observation time housed with Delilah (N = 72 focal samples), 28% with Jackson (N = 36), and 15% with Chloe (N = 19).

Table 10

Delilah Allogrooming Durations

Configuration	Total time (minutes)	Time Delilah initiated behavior (minutes)	Time mate initiated behavior (minutes)
1 – Leah	15.27	0	15.27
2 – Jackson	17.77	5.57	12.20
3 – Chloe	0	0	0

I used a Kruskal-Wallis ANOVA with alpha set to 0.05 to determine behavioral differences for feeding ($N = 236$ observations), inactivity ($N = 383$), locomotion ($N = 356$), self-grooming ($N = 94$), and allogrooming ($N = 31$) with Leah as the focal animal. The results (Table 11) showed no significance across all behaviors of feeding ($\chi^2 = 1.12$, $p = 0.57$), inactivity ($\chi^2 = 0.71$, $p = 0.70$), locomotion ($\chi^2 = 4.65$, $p = 0.10$), self-grooming ($\chi^2 = 2.55$, $p = 0.28$), and allogrooming ($\chi^2 = 4.38$, $p = 0.11$). I compared the behaviors by the durations of each behavior in each configuration (Figure 10). Leah spent a total of 111.52 minutes allogrooming ($N = 31$ observations) within the 127 focal samples and she initiated the behavior 74% ($N = 82.47$ minutes) of total observation time when she was the focal animal (Table 12).

Table 11

Statistical Summary for Leah's Behaviors in All Housing Configurations

Behavior	df	χ^2	*p*-value
Feed	2	1.12	0.56
Inactivity	2	0.71	0.70
Locomotion	2	4.64	0.09
Self groom	2	2.54	0.27
Allogroom	2	4.38	0.11

Figure 10

Durations of Five Behaviors for Leah in Configurations 1 (Delilah), 2 (Chloe), and 3 (Jackson)

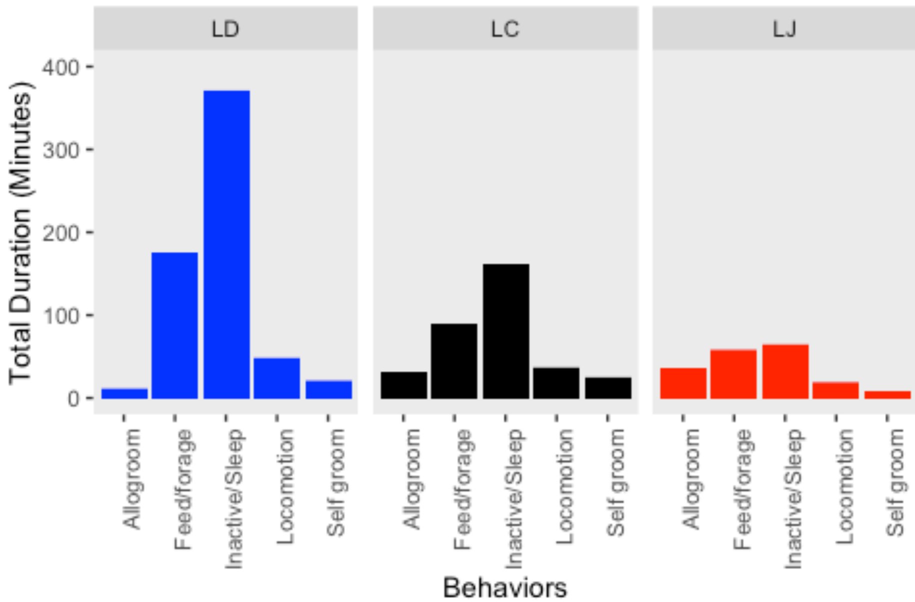


Table 12

Leah Allogrooming Durations

Configuration	Total time (minutes)	Time Leah initiated behavior (minutes)	Time mate initiated behavior (minutes)
1 – Delilah	15.27	15.27	0
2 – Chloe	60.38	47.37	13.02
3 – Jackson	35.87	19.83	16.03

CHAPTER V

DISCUSSION

Primates are unique individuals that show a variety of different behaviors and personalities. Chimpanzees are among a population of great apes with complex abilities including self-awareness, problem solving, decision making, and reasoning (de Waal, 2005; Goodall 1971; Goodall, 1986; Lonsdorf, 2010). Aggression is typically limited in captivity because individuals are always provided with food by caregivers and groups do not have to defend their territories from other groups. Chimpanzees live in complex hierarchical communities where there is a dominant individual, typically a male (Goodall, 1971; Goodall, 1990). Group organization in captivity can be drastically different than wild populations simply because it is not a natural, free environment. However, social structures can remain the same.

The goal of my study was to further understand social interactions in a small group of chimpanzees that are older in age and determine which individuals would be best suited for initiating the future introduction processes to a new group of chimpanzees at the Oregon Zoo. I used five different behaviors to compare their interactions in three different housing configurations. Alongside Ross and colleagues' (2010) study, this study is one of the few that explores behaviors in different environments with different group members. Building off of a study done by Baker (2000), I focused on a specific group of chimpanzees in order to aid in the social management strategies of aged populations in captive apes.

I predicted that the chimpanzees would be housed with one chimpanzee than the remaining two of the group. This prediction was supported by a significant result from a chi square test of independence. In addition to formally testing the prediction, I calculated the amount of time each individual spent in each housing configuration. The durations for each chimpanzee in each configuration are correlated with one another. Jackson and Chloe spent over 50% of observation time with one another, meaning that Delilah and Leah also spent over 50% of observation time as a configuration pair. Each chimpanzee spent approximately 30% and 15% of observation time in the other two configurations. The keepers rotated the chimpanzees during the temporary construction time and shifting of individuals between indoor and outdoor enclosures. These rotations were influenced by whom the chimpanzees positioned themselves in close proximity to each morning before the keepers opened the doors to the respected enclosures. Allowing the chimpanzees to influence where and with whom they intended to spend their day provides them with opportunities of choice and control in an environment that is strictly managed by humans on a day-to-day basis (Ross et al., 2011). At times, caregivers would intentionally guide the configurations while keeping close watch on an individual or preventing intragroup aggression. These results show that there is a clear unequal distribution of time in each configuration and that each of the chimpanzees was more comfortable being housed with a certain individual. Over 50% of time in configuration compared to around 15% in another is a drastic difference. It could be possible that caregivers take note of the two strong social bonds, Jackson and Chloe as well as Delilah and Leah, and keep those pairings together more often because they are stable groups.

A second chi-square test of independence, based on the configurations that were in place at the beginning of each day, revealed a non-significant result. Although configurations did not change very often, there were days where the groups were switched midday. This typically occurred when the group was split as a group of three and a solo individual or in the case of intense intragroup aggression.

Jackson

Jackson is the most unique individual of the chimpanzee group because of his troubled past. Humans were a large part of his life and consequently, he lacks natural behaviors we typically see in chimpanzees. He is the most recent arrival to the Oregon Zoo and had to form social bonds with three females, including two sisters, who have lived together for over 40 years. My prediction was that he would show a stronger bond toward one individual through grooming behavior. In housing configuration three, Jackson and Leah, there were no grooming observations when Jackson was the focal animal. The results of a Mann-Whitney U test showed no significance in comparing grooming behaviors between him and either Chloe or Delilah. However, there was a large difference in the grooming durations. This could also be due to the total amount of time Jackson spent in each configuration. He was housed with Chloe the most, followed by Delilah then Leah, but still showed the smallest engagement in grooming with Delilah. Grooming is a behavior that chimpanzees use to create or strengthen social bonds as well as indicate reassurance in aggressive instances (Stumpf, 2011; Stanford, 2018). Although test results did not show a p-value of less than 0.05, Jackson's grooming behavior could indicate that he enjoys spending more time with Chloe and has a stronger relationship with her than Delilah or Leah.

Despite the difference in the amount of time he spent with each chimpanzee, Jackson showed a similar trend in inactivity, feeding, and locomotion behaviors in each configuration with the exception of the absence of allogrooming with Leah. Self grooming was the lone significant result in Jackson's behaviors from a Kruskal-Wallis test. From the boxplot (Figure 10) of self grooming behaviors, it is visible that the largest difference is between configurations one, with Chloe, and two, with Delilah. A previous study has shown that chimpanzees engage in higher rates of self-directed behaviors when they lack environmental complexity and/or varied human or conspecific interactions (Ross et al., 2010). Location did not play a role in my analysis of behaviors, but conspecific interactions were often changing over the course of the study.

Chloe

Chloe is the smallest, the oldest, and the alpha of the group and she uses that hierarchical power to snatch desired enrichment items and food to gain possession from other individuals. Every time I observed these behaviors, Leah was the other individual. Chloe took food, blankets, and nests from Leah without a fight. Although there are deviations between configurations in behavioral durations, the prediction that Chloe would show differences in behaviors depending on which individual she was housed with was not entirely supported with a Kruskal-Wallis test, as there were no significant results.

In housing configuration three, Chloe and Delilah, there were no grooming observations when either of them were the focal animal. The results of a Mann-Whitney U test showed no significant results of grooming in housing configurations one and two as Chloe spent a similar amount of time grooming both Jackson and Leah. In the rare times where the group was split into three and one, I observed grooming in a triad of Chloe, Delilah, and Leah. This was the only time that Chloe and Delilah groomed while they were together. Even with only two configurations with observations, Chloe engaged in grooming the most compared to Jackson, Delilah, and Leah. Most of the observations for her grooming were with Jackson. A previous study on wild chimpanzee dominance at Gombe National Park was conducted and the results showed that each alpha chimpanzee uses grooming as a dominance tactic in different ways (Foster et el., 2009). Body mass contributes to the amount of grooming each individual partakes in, meaning that smaller chimpanzees will groom more than larger chimpanzees in order to achieve alpha status (Foster et al., 2009). Since Chloe is the smallest individual of the group of four chimpanzees at the Oregon Zoo, her size could be a determinant factor in her grooming rates.

Delilah

Even though Delilah was housed with Leah for the majority of the time, her rates of inactivity were significantly higher in that configuration than the others. These results were supported by a Kruskal Wallis test with alpha set at 0.05. Furthermore, a Nemenyi pairwise multiple comparison test showed that the largest difference in inactivity behaviors was between configurations one, with Leah, and three, with Chloe. Overall, Delilah's activity budget was low in comparison to the other chimpanzees. She spent much more time either sleeping or resting, especially in configuration one with her younger sister, Leah. Toward the end of my research, Delilah was held in the indoor enclosure for five days in a row. According to the caregivers (C. Reed, personal communication, November 14, 2019), I understood that she was sick with a cold and they wanted to keep a close eye on her while she was recovering. I saw a reduction in activity levels during this time, which could be a result of her health conditions as well as her age. For those five days, she was housed with Leah, perhaps as a source of comfort while she was unwell. Similar to Jackson, Delilah showed a consistent trend of behaviors despite whom she was housed with. Locomotion and feeding/foraging were nearly equal within each configuration followed by allogrooming and self grooming, which were also nearly equal.

In housing configuration three, Delilah and Chloe, there were no grooming observations when either of them were the focal animal. The results of a Mann-Whitney U test showed no significant results of grooming in housing configurations one and two, as Delilah spent a similar amount of time grooming both Jackson and Leah. In the rare times where the group was split into three and one, I observed grooming in a triad of Delilah, Chloe, and Leah. Two out of three of these rare configurations were the only times that Chloe and Delilah engaged in any grooming activity together; when Leah was housed with them. Across all observations on the four chimpanzees, Delilah groomed for the least amount of time (N = 33.04 minutes) and initiated the behavior only 17% of observation time when she was the focal animal.

Leah

Using a Kruskal-Wallis test, I tested the prediction that Leah would show differences in behaviors depending on which housing configuration she was in. The prediction was not supported by the results, but the distribution of durations shows a difference in each behavior within each configuration. Leah spent over half of observation time with Delilah, when either of them were the focal animals. They have a strong social bond because they are sisters and have lived every day of their lives together at the Oregon Zoo. When I observed and recorded Leah grooming, she initiated the behavior 74% of the time. Leah and Jackson are the most subordinate group members. Grooming other group members more often could be a strategy to create stronger social connections within the organization (Stumpf, 2011; Stanford, 2018). Despite spending over 50% of their time together, Leah and Delilah showed the least amount of grooming behavior of only 15.27 minutes. Leah initiated the behavior in every instance that it occurred. Behavior trends are similar across each configuration; however, the rate of inactivity was lower when she was housed with Jackson. Leah spent the least amount of observation time with Chloe, but engaged in grooming and feeding/foraging more often than she did with Jackson. This could be a result of Chloe's dominance or simply a stronger relationship with Chloe than with Jackson. Throughout my data collection, I observed Chloe stealing food or enrichment items from Leah as well as pushing Leah out of a nest. The antics of the alpha chimpanzee could cause other individuals to alter their behaviors. In this case, Leah would collect more food to compensate for the potential of Chloe taking her belongings.

Other Behaviors

Although I did not test for all observed behaviors in my study, the chimpanzees did engage in behaviors that include visitor interaction, object manipulation, observing construction, vocalizations, and social play. Each individual has a distinct personality and engaged in certain behaviors more than their group members. For example, Chloe interacted with visitors, usually children, by traveling down and placing herself directly on the opposite side of the glass from the humans. When a visitor would extend and touch the glass, she would kiss the glass with her lips wherever the human hand was. Visitor presence can influence chimpanzees in captivity by causing them to shift locations and/or change their behaviors (Herrelko et al., 2015; Bonnie et al., 2016). The construction of the new chimpanzee exhibit was visible from the upper view of the outdoor enclosure. In that area, Chloe spent 17.88 minutes observing the construction from a distance. I observed abnormal behaviors scattered throughout my study. Some of these included rocking and coprophagy. I recorded Delilah rocking 111 times for a total of 34.4 minutes. Leah engaged in coprophagy most often for a total of 8.35 minutes. Jackson's pacing behaviors could be considered abnormal, however, I typically observed those behaviors when the caregivers would arrive for a feeding session. This behavior was almost always in anticipation for food as he would also stop and look through doors or windows to see the caregivers preparing meals or enrichment items. I rarely observed vocalizations, social play, and aggressive behaviors, but the chimpanzees did engage in species-typical behaviors from each of these categories. Previous studies suggest that the composition of the surrounding environment could influence the occurrence of abnormal behaviors (Ross et al., 2010; Ross et al., 2011).

Conclusions

Jackson, Chloe, Delilah, and Leah are unique individuals who all showed consistent trends in behaviors. Each chimpanzee has her or his individual differences and personalities with respect to how they behave, but there was a pattern throughout the data because of the amount of time each chimpanzee spent with the others in the group. Nearly all of them spent the most time inactive, followed by feeding/foraging. Although grooming behaviors did not occur as often as other behaviors, the effects of overgrooming, either solo or with a social partner, are visually present on all of the chimpanzees as they have bare spots where you can see their skin. Overgrooming can occur more often in captivity as an abnormal behavior that individuals engage in to pass the time (Birkett & Newton-Fisher, 2011; Farley, 2016; Hosey, 2000). Over the course of my research, I recorded three half days where the chimpanzees were separated into a group of three and one. There were slightly more social interactions in these configurations and, as expected, more inactivity for the solo individual. Chloe and Jackson were the only two that were by ever housed by themselves, while Delilah and Leah were always within the group of three. In terms of grooming behaviors, Chloe and Delilah did not groom together at all during my observations unless they were in the presence of Leah. Even though there were only three instances where the configurations were split into three and one, I observed this grooming pattern two out of three times. Although Leah one of the subordinate females, she still has strong social relationships. In the case of the three females, she is the bridge of the bond between Delilah and Chloe. Chimpanzees are socially complex individuals and should be housed with other chimpanzees. In the wild, they typically reside in groups of at least 15 individuals (Stumpf, 2011; Stanford, 2018; Goodall, 1986). The configurations of three and one individuals did not last for a whole day, making it a rare situation with a single chimpanzee in her or his own enclosure.

Throughout my study, the majority of behaviors that I recorded and analyzed were low activity. The chimpanzees at the Oregon Zoo at the time of my study are considered geriatric, as they are all ≥ 45 years old. The new individuals that are set to arrive at the zoo in the near future range in ages from juvenile to full grown adults. It would be interesting to conduct a study on their activity levels after they are settled into their new home and a new group of mixed ages. The new group composition could potentially stimulate more activity in the older individuals, especially the females. With younger chimpanzees in their group, they will have the opportunity to act as a surrogate mother or aunt. Younger chimpanzees will be new territory for Delilah and Leah, as they have spent their entire lives at the zoo. The introduction of new chimpanzees could also cause conflict with the current group in the case of potential dominance takeovers and each individual finding a place in the new family (Baker, 2000).

Recommendations for Future Research

My study was specific to the Oregon Zoo chimpanzees and the construction of new enclosures. With the future of the zoo, it would be beneficial for others to use my study as a baseline to compare how behaviors and social interactions are different between the two different enclosures. After the completion of construction, the introduction process will begin for Jackson, Chloe, Delilah, and Leah as they are moved to a new enclosure. My study can provide valuable insight to the zoo staff in deciding which individuals from the current group would be best suited to introduce to the new group of chimpanzees first. It can also guide caregivers to consider different living arrangements and which of those would be best for strengthening groups as a whole. As chimpanzee introductions are complicated and unpredictable, determining the strongest social bonds of a group can help with potential living arrangements. When integrating individuals into a new group, it is important to understand how they interact with their current, or previous, group members. Using a small group, or pair, from a current group and the same from a newer group may allow for a smoother transition rather than a larger group and a single individual. The alpha chimpanzee may be too powerful and controlling to integrate first, which can complicate the process of creating new social relationships and potentially cause problems or induce aggression. The most social chimpanzees that are not in a dominant position may have the most success with fitting in to a group of unfamiliar individuals. As Baker (2000) stated, the group size and composition during introduction procedures could be tailored to the older residents' social bonds in order to ease the process. Future research could also consist of a study similar mine, but in the new enclosure with the larger group. Collecting behavioral data after construction would be beneficial in determining and comparing how the change has affected the four geriatric chimpanzees in my study.

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APPENDIX

APPENDIX A

Table 1A

Full Chimpanzee Ethogram

Behavior	Code	Description	Source
Coprophagy	C	Deliberate ingestion of feces	AZA, 2010
Urophagy	U	Deliberate ingestion of urine from themselves or another individual	AZA, 2010
Regurgitation/ Reingestion	RR	Deliberate regurgitation accomplished by various methods including lowering head to the ground, bobbing head, or more subtle techniques. The vomits may be retained within the mouth or expelled into hand or substrate before being reingested.	AZA, 2010
Pace	P	Locomote, usually quadrupedally, on substrate, covering and then re-covering route in stylized fashion, with no clear objective	Birkett & Newton-Fisher, 2011
Rock	R	Sway repetitively and rhythmically, without pilo-erection. Usually side-to-side movement, but may be forward and backward or full circular motion of torso. Usually whole body, sometimes just the head	Birkett & Newton-Fisher, 2011
Train shuffle	TS	Short quick steps across the ground	My own
Fecal smear	FS	Smearing and/or rubbing feces on a surface	National Primate Research Centers
Foot Tap	FT	Fast pace, repetitive movement of the heel up and down in a non-play context	Farley, 2016
Bob	B	A rapid and repetitive up and down motion of the body on flexed limbs without leaving the surface	National Primate Research Centers
Bipedal Swagger	BS	An upright or semi-upright posture, swaying from one foot to another	Farley, 2016
Hit self	H	Slap own body part with hand or	Birkett & Newton-

		foot	Fisher, 2011
Hit other	HO	Slap conspecific with hand or foot	Nishida et al., 1999
Display/Threat	D	Aggressive behavior without any clear and identifiable recipient. May include pilo-erection, and such behaviors as beating on or moving inanimate objects, stomping, slapping, swaying, hooting, chest-beat, or running	AZA, 2010
Charge	CH	Quadrupedal locomotion with limbs moving fast and brought higher off the ground, head tucked far down into shoulders, angle of back horizontal, slapping sound usually with pilo-erect hair	Farley, 2016
Feed/Forage	F	Individual is handling, manipulating or ingesting food items. Includes foraging through bedding or other materials in search of desired food items	AZA, 2010
Inactive	I	Subject rests or is motionless	Ross et al., 2010
Horizontal Locomotion	HL	Individual changes location in horizontal space by walking, running, crawling, etc. The change in location must be greater than one body length	AZA, 2010
Vertical Locomotion	VL	Individual changes location in vertical space by climbing, sliding, jumping, etc. The change in location must be greater than one body length	AZA, 2010
Object Manipulation	OM	Subject interacts with a feature of the environment, including natural and non-natural items	Ross et al., 2010
Allogroom	AGM	Picking through hair or at skin of another individual and removing debris with hands and/or mouth	Herrelko et al., 2015
Self Groom	SG	Picking through own hair or skin removing debris	Baker, 2000
Social Play	SP	Non-aggressive interactions involving two or more animals. Never accompanied by pilo-erection or agonism; may be accompanied by play-face and/or laughing. Includes rough-and-tumble play, quiet play, and social	AZA, 2010

		play initiation	
Sleeping/nesting	SN	Subject is lying on it's side and/or sleeping	My own
Embrace	E	Gentle contact to another individual using the arms or another body part	Farley, 2016
Vocalization	V	Grunts, screams, barks, pants, hoots, and/or calls	Nishida et al., 1999
Extend	EX	Reach arm or leg to another individual	Nishida et al. 1999
Vigilance	VI	Keeping careful watch for possible danger or difficulties	Dictionary
Present	PR	Quadrupedal posture with limbs flexed, hindquarters turned toward another individual	Nishida et al., 1999
Crouch	CR	Quadrupedal posture with limbs flexed, hindquarters not turned towards another individual	Nishida et al. 1999
Other	O	Behaviors that are not listed in ethogram	My own
Out of View	OV	Individual's behavior is not able to be identified due to visual obstruction	AZA, 2010
Observe Construction	OC	Subject is keeping careful watch of construction activity	My own
Visitor Interaction	VI	Subject acknowledges and/or interacts with a visitor	My own