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The Use of Personality Assessments in Designing Environmental Enrichment for Garnett's Bushbabies (*Otolemur garnettii*)

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by

Lauren Elizabeth Highfill

A Dissertation
Submitted to the Graduate Studies Office
of The University of Southern Mississippi
in Partial Fulfillment of the Requirements
for the Degree of Doctor of Philosophy

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ABSTRACT

THE USE OF PERSONALITY ASSESSMENTS IN DESIGNING ENVIRONMENTAL ENRICHMENT FOR GARNETT'S BUSHBABIES (*OTOLEMUR GARNETTII*)

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Recently the study of animal personality has become an important and credible topic of research and a number of studies have revealed personality traits in a variety of species. The consideration of individual animal personality traits is important for animal management and welfare. For example, ensuring inter-individual compatibility in group housing animals may serve to ensure the safety of the whole group. To date, no formal research has been conducted on whether the assessment of individual personality traits could be used as a tool for individualizing environmental enrichment interventions. The goal of environmental enrichment is to increase the rate of species-typical behaviors in captive animals. Prior research has, for the most part, implemented enrichment strategies generically, exposing all animals to the same intervention (de Azevedo, et al., 2007). However, individual animals have unique problems or preferences, and could benefit from enrichment plans tailored specifically for them. Testing multiple enrichment options with all individuals of a large group would be very time-consuming and cost-prohibitive. A possible solution is to assess the different personality traits within the group of animals, and provide various enrichment interventions specific to these individual differences. Thus, the current study examined whether certain enrichment options are more effective for particular personality traits within a prosimian species. Personality traits of ten Garnett's bushbabies were assessed and the subjects were categorized as either high or low on five personality factors: Extraversion, Openness to Experience, Conscientiousness, Agreeableness, and Neuroticism. All ten subjects were exposed to five different environmental enrichment interventions. The

effectiveness of each enrichment intervention was assessed by examining stereotypic behaviors before and after exposure to the enrichment interventions. All five enrichment interventions generally improved animal welfare by increasing frequency of species-typical behavior across the subjects. In addition, some of the enrichment interventions differentially benefited the subjects based on their individual personality traits. For example, following being housed with an unfamiliar conspecific, highly agreeable (more affiliative and friendly) subjects significantly decreased their maladaptive behaviors. Overall, this study suggests that individualized plans of enrichment related to personality differences are beneficial to a prosimian species.

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CHAPTER I

OVERVIEW OF ANIMAL PERSONALITY

History of Animal Personality Research

One of the first arguments for the existence of animal personality came from Darwin (1964). He believed that personality traits (defined as consistent individual differences in behavior) were present in animals, and he also suggested that these behavioral traits could evolve in the same way as physical traits. However, during the mid 20th century, psychologists began to more often take a normative approach rather than an idiosyncratic approach (Mather, 1998). The emergence of behaviorism, which assumed that animals were simply vehicles on which general rules of behavior could be demonstrated, assumed that organisms were inherently similar and only differed as a result of environmental influences (Buckley, 1989). In addition, the pressure for statistical proof of behavior change was great in psychological research. During this time, an emphasis was placed on collecting large sample sizes and calculating an average of behaviors instead of examining behaviors independently (Mather, 1998). Large sample sizes were studied and variation was considered to be noise. Researchers during this time considered individual variation unimportant for understanding the overall meaning of animal behavior. For example, a study of social play behavior in a group of 168 rhesus monkeys (Chamove, Eysenck, & Harlow, 1972) was interested in the common social play behaviors in the rhesus monkeys and not any individual differences. Finally, the strong ethological notion of species-specific behaviors such as fixed action patterns (Mather, 1998) bolstered the idea that individuals of a given species performed essentially identical behaviors. For example, one study observed the behavior in the wild parasitic wasp and found 15 distinct fixed action patterns used for grooming (Thelen & Farish, 1977). This concept increased the focus on the average of behaviors among a species while ignoring any individual variation. Later that century, though, the focus began to shift back to the study of consistent individual differences.

Pioneering studies of animal personality appeared in the 1970s (e.g., Adamec, 1975; Buirski, Plutchik, & Kellerman, 1978; Stevenson-Hinde & Zunz, 1978). These studies proposed personality differences and looked for behavioral tendencies that would be predicative of those personality traits. One of these early studies investigated behavioral differences between rat-killing cats and non-rat killing cats (Adamec, 1975). The cats were measured on four different responses: (1) response to novelty; (2) aggressive responses to live prey; (3) social interactions with humans; and (4) defensive responses to threat howls from an aggressive male cat. From this investigation, the author found that non-rat killing cats were more defensive and had an enhanced sensitivity to external threats than rat-killing cats. Another study had observers rate the personality traits of rhesus monkeys living within a colony (Stevenson-Hinde & Zunz, 1978). The observers used behaviorally defined adjectives to rate the animals using 7-point scales. From these ratings, three dimensions of personality were formed: confident to fearful; active to slow; and sociable to solitary. This method of assessment proved to be quite fruitful and a modified version of this personality assessment scale is still being used in animal personality studies. These studies began a surge of interest in consistent individual characteristics among individuals of various species, and during the past few years, research has begun to focus on animal personality more seriously. This line of research has resulted in a number of studies revealing individual differences in personality traits in such diverse species as primates, marine mammals, insects, fish, invertebrates, and birds (see Gosling, 2001, for review).

Benefits of Animal Personality

Animal personality research offers a number of both practical and theoretical benefits. Examining individual differences enables animal caretakers to better understand and predict the behavior of animals (Vazire & Gosling, 2004). Moreover, understanding individual differences can directly benefit the animals. Zoos and farms can more effectively manage animals and maintain their welfare if they can consider the specific characteristics of the individuals. For example, ensuring inter-individual compatibility in group housing animals may serve to ensure

the safety of the whole group. Furthermore, knowledge of personality types can aid in animal management techniques, such as breeding and reintroduction programs. For instance, one study examining cheetahs living under human care suggested ways that using personality and behavioral assessments could aid in predicting individual abilities to successfully reproduce (Wielebnowski, 1999). She suggested that individuals scoring high on the trait "tense-fearful" would have more trouble coping with the captive environment and, therefore, be less successful in producing and rearing offspring. Such individuals, if placed in more isolated areas or provided with more hiding places to alleviate tense or fearful behaviors may show increased reproductive success.

Animal personality studies can also provide useful comparisons and insights for the field of human personality development. For example, animal studies are helpful when investigating the impact of early environment on the ontogeny of individual behavioral differences (Gosling, 2001). One study by Markowitz and colleagues (1998) examined the effects of increased handling and artificial feeding of newborn domestic sheep. In this study, all experimental subjects were fed a milk substitute and handled for five minutes four times per day. Following the treatment period, the subjects' affinity for humans was assessed by viewing a subject's response to both a sitting and walking person. Their results indicated that lambs that had been exposed to increased handling and artificial feeding had a significantly greater affinity for humans than the lambs that did not. A different study by Clarke and Snipes (1998) demonstrated the effects of mother vs. peer-rearing in rhesus monkeys. For their study, they separated 48 infant monkeys into two groups: mother-reared and peer-reared. After eight to ten months, scales were used to rate the monkeys on 10 behavioral characteristics (e.g. anxious/calm, dependent/independent). The results indicated that peer-reared animals were less cautious and more attentive to the environment than mother-reared animals. These findings are important for understanding how the development of personality traits can be affected by environmental events.

Recently, it has been suggested that researchers should expand the uses of animal models to study how personality could influence disease susceptibility and resilience. In her paper, Cavigelli (2005) described various ways in which animal models of personality could be very beneficial for health research by providing a unique complement to human studies. For example, she explained how research with animal models can involve more experimental manipulation unlike the predominantly correlational research performed with humans. Additionally, lifespan longitudinal studies can be performed with short-lived animal models, which would also help to address more collective effects of personality on health. Overall, animal models of human personality characteristics play an essential role in understanding the many different dimensions of human behavior.

Research Methods for Animal Personality

Currently, there are two methods used to study animal personality: coding and rating. The coding method involves researchers coding an animal's reaction within either a novel or familiar situation (Gosling, 2001). Coding an animal's behavior during a naturally occurring activity such as eating or grooming is known as ethological coding (Vazire & Gosling, 2004). This system was used in Capitanio's (1999) study of sociability in rhesus macaques. Capitanio observed and coded the behaviors demonstrated by rhesus macaques while they interacted with their social groups. From these codes, four main personality dimensions emerged: sociability; confidence; excitability; and equability. The coding method can also be used in experimental settings. In one such study, wild-caught octopi were presented with a series of behavioral tests designed to reveal their individual differences (Mather & Anderson, 1993). During these behavioral trials, the animals' reactions were recorded and coded. From the tests, Mather and Anderson observed three main personality groupings: activity; reactivity; and avoidance. During one of their test situations, the experimenter placed a test-tube brush into the tank and brought it slowly toward the octopus, thus creating a possible threat to the animal. A reactive octopus would squirt water at the "threatening" test tube brush, whereas an avoiding octopus would simply shrink away.

The second technique used in animal personality research is known as the rating method. This method involves a group of observers who make judgments about an individual animal's behavioral traits (Vazire & Gosling, 2004). The validity of this method depends on the extent to which the observers know the animals. Usually the observers are given a list of adjectives or descriptions, which they use to rate each individual. For example, Gosling (1998) had four observers, who were very familiar with the subjects, provide personality ratings for a group of spotted hyenas. The observers used a list of 44 behavioral descriptions to rate each individual on a 5-point scale (1- extremely uncharacteristic to 5- extremely characteristic). From his analyses, Gosling suggested that hyena personality traits can be placed into five broad dimensions: Assertiveness, Excitability, Human-Directed Agreeableness, Sociability, and Curiosity. This five factor grouping is similar to the groupings that have been used with other species, including primate species (e.g. Bolig et al., 1992; McGuire et al., 1994).

Some researchers believe that the best way to study personality in animals is to employ a combination of both coding and rating techniques (Mather, 1998; Vazire & Gosling, 2004). This combination generates more information and may increase the validity and reliability of the measures (Vazire & Gosling, 2004). For example, one study examining personality in the black rhinoceros first used the rating method by having keepers from 19 zoos rate their respective rhinoceros (Carlstead, Mellen, & Kleiman, 1999). Next, the coding method was employed by administering behavioral tests to the same rhinoceros. These tests helped to evaluate the extent to which the behavioral ratings and the behavioral codings matched. Their findings indicated that each rated behavior trait was matched significantly with the animals' observed behaviors. For example, rhinoceros which were rated as "fearful" by their keepers were also coded as "fearful" during the behavioral tests.

While there are many standardized measures for the study of human personality (Cloninger, 1996), the assessment techniques for animal personality have historically been viewed as subjective and anecdotal. More recently, animal personality research has gained greater

viability with tests of reliability and validity (Cloninger, 1996). Another important element of personality is its relative consistency across time and situations. For humans, the consistency of how an individual's behavior is perceived by another is thought to be important evidence for human behavior as being structured within specific intentions and emotions (Morris, Fidler, & Costall, 2000). Therefore, when behavioral descriptions for animals are found to be consistent over time and across situations, the same claim could be made. Consistency is assessed via test-retest procedures, which examine whether an individual exhibits similar behavioral traits during separate testing occasions. One such study examining rhesus monkeys employed the test-retest procedure by rating each individual every year for four years (Stevenson-Hinde, Stillwell-Barnes, & Zunz, 1980). Their results indicated that some personality traits were stable year to year. For example, "confident" was the most stable trait despite age or sex, and its stability may be linked to dominance. Highfill and Kuczaj (2007) examined the stability of individual dolphin personality traits over time and across situations. Twelve out of 15 bottlenose dolphins demonstrated consistent personality traits after enduring changes in their environment and social group as a result of Hurricane Katrina. These findings parallel an earlier conclusion found in human personality research, which is that consistency over time among personality traits emerges when observers properly judge individual behaviors (Block, 1977).

Current Problems Facing Animal Personality Research

There are a number of methodological and procedural issues that have added to the difficulties of conducting personality research with nonhuman animals. The literature on animal personality has not always employed consistent terminology. Animal personality studies often explore behavioral dimensions that have similar qualities, but nonetheless use different terminology. For example, Forkman and colleagues (1995) discussed the personality trait of "exploration" in piglets, whereas Gosling (1998) used the term "curiosity" in his study of a group of hyenas. However, operational definitions of these two personality traits suggest that they are describing the same set of behavioral tendencies. Terminology inconsistencies within species can

also lead to difficulties in animal personality research. For example, Svartberg and Forkman (2002) investigated dog personality traits using the coding method to determine each subject's reactions to certain tests. Some of these tests included reactions to strangers and reactions to "fleeing" prey-like objects (Svartberg & Forkman, 2002). A factor analysis was used to determine the presence of five traits: "playfulness;" "curiosity/fearfulness;" "chase-proneness;" "sociability;" and "aggressiveness." Gosling and John (1999) had dog owners rate their pets using a personality scale and similar traits emerged: "emotional reactivity;" affection;" "energy;" and "competence" (Gosling & John, 1999). Although these traits do not have the same names, they appear to reflect similar characteristics (e.g. "playfulness" and "energy"). Thus, there is a need for terminological consistency within animal personality research in order to allow meaningful within and across species comparisons. One possible solution is to devise an animal personality measure that is based on measures used in the study and assessment of human personality. For example, King and Figueredo (1997) used a modified version of the Five Factor Model for a group of chimpanzees. In human psychology, the Five Factor model is a descriptive model of personality (Goldberg, 1990). The model includes five broad factors or dimensions of personality including: Openness to experience, Conscientiousness, Extraversion, Agreeableness, and Neuroticism (Goldberg, 1993). Each factor consists of more specific traits. For example, the factor openness to experience is characterized by a sense of adventure, unusual ideas, imagination and curiosity. The factor of conscientiousness is characterized by a tendency to show self-discipline, demonstrate planned behaviors and aim for achievement. The factor extraversion is characterized by energy, surgency, and the tendency to seek stimulation. The factor agreeableness is characterized by a tendency to be cooperative rather than antagonistic towards others. The final factor of neuroticism is characterized by a tendency to experience unpleasant emotions easily, such as anger or anxiety (Goldberg, 1993). King and Figueredo (1997) found evidence for each of the five factors in the chimpanzees they studied. Another study also used this novel approach to examine personality traits in horses (Morris, Gale & Duffy, 2002). For this research, nine animal

caretakers rated 10 horses using a slightly modified version of a human Five Factor Inventory, (Costa & McCrae, 1992). This highly reliable test for humans was also reliable when applied to horses. Furthermore, all five factors emerged from the ratings: Extraversion, Agreeableness, Neuroticism, Openness to experience, and Conscientiousness, with the strongest factors being Neuroticism and Extraversion. In an effort to encourage cross-species comparisons of animal personality, Gosling and John (1999) retrospectively applied the Five Factor dimensions to 12 non-human species taken from 19 published studies of personality. They were able to apply four of the five factors (Openness to Experience, Extraversion, Agreeableness, and Neuroticism) to all 12 species and were able to apply all five factors to chimpanzees.

CHAPTER II

REVIEW OF LITERATURE ON ANIMAL PERSONALITY

Non-human Primates

Personality studies have been performed with a variety of species. Probably the most thoroughly studied group of animals in personality research is the primate group (e.g. chimpanzees: Bard & Gardner, 1996; Buirski et al., 1978; Buirski & Plutchik, 1991; Dutton et al., 1997; King & Figueredo, 1997; Lilienfeld et al., 1999; Murray, 1998; gorillas: Gold & Maple, 1994; vervet monkeys: Faribanks & McGuire, 1993; McGuire et al., 1994; macaques: French, 1981; Figueredo et al., 1995; rhesus monkeys: Bolig et al., 1992; Capitanio, 1999; Suomi, 1991; baboons: Buirski et al., 1973; Sapolsky & Ray, 1989; bushbabies: Watson & Ward, 1996). Generally, research has found that non-human primates have the largest variety of personality characteristics and dimensions when compared to other species.

In one of the earlier studies on primates, Buirski and colleagues (1978) assessed the reliability of rating personality characteristics in chimpanzees. In this study, observers reliably rated a group of chimpanzees using an Emotions Profile Index, a scale which focused on the adaptive significance of emotions. They also found that sex differences had an effect on personality characteristics, with females being more timid, depressed and trustful, while males were more distrustful and aggressive.

In a more recent study, the effect of rearing conditions on personality characteristics in chimpanzees was examined (Martin, 2005). Chimpanzees from five zoos in the United Kingdom were categorized into three rearing conditions: mother-group-reared (MGR), reared with others but separated from mother (RO), and reared alone for a period of time during infancy (RA). Then, observers used 25 behavioral adjectives to rate personality characteristics of the subjects. Three personality dimensions emerged from the ratings: an aggressive male type; a confident female type; and an apprehensive female type. However, there did not seem to be a relationship between individual personality traits and rearing condition.

Weiss and colleagues (2006) examined 152 orangutans from 41 zoological parks which were rated by employees who were familiar with the animals. Each rater used a questionnaire with 48 personality descriptors to assess orangutan personality. The results suggested that orangutans have five reliable personality factors: extraversion, dominance, neuroticism, agreeableness and intellect. Furthermore, 140 of the subjects were also rated on a subjective well-being questionnaire. These ratings suggested that the factors of extraversion, agreeableness and low neuroticism were related to subjective well-being.

A different study in primates investigated the relationship between problem solving skills and personality (Watson & Ward, 1996). Specifically, this study examined the relation between problem-solving skills on personality characteristics in Garnett's bushbabies. The subjects were placed in different situations: an empty, open field, an open field with novel objects, and an open field with a live caged snake. From these tests, four personality dimensions were revealed: activity, curiosity, boldness, and escape. The same subjects were then tested on a latch-box problem. The subjects who had correctly completed the latch-box problem had higher curiosity scores than those subjects who did not solve the task. These findings indicated a possible link between personality and cognitive abilities in a primate species.

Overall, personality studies with primates have proved successful, although not every study reveals the same personality factors. For example, King and Figueredo's (1997) study suggested that chimpanzees have six personality dimensions: emotional stability, agreeableness, surgency, openness, dependability, and dominance. However, a different study by Bard and Gardner (1996) suggested that chimpanzees possess only four dimensions: audiovisual reactivity, affect-extraversion, task behavior and activity. This discrepancy may reflect the different methods used. King and Figueredo used a rating method, whereas Bard and Gardner used a coding method to categorize body motions. Thus, the need for consistency within personality descriptions and methods is emphasized.

Other mammals

The personalities of many other mammal species have also been studied (e.g. dogs: Murphy, 1995; Svartberg & Forkman, 2002; cats: Feaver et al., 1986; goat: Lyons et al., 1988; cows: Boissy & Bouissou, 1995; horses: Mills, 1998; Morris et al., 2000; wolves: MacDonald, 1983; foxes: Harri et al., 1995; spotted hyenas: Gosling, 1998; deer: Pollard et al. 1994; and pigs: Forkman et al., 1995). One of the more interesting and unique applications of animal personality traits is demonstrated in a study in which researchers examined personality traits in donkeys that were being sent to foster homes (French, 1993). When originally judged, these donkeys were housed at the Donkey Sanctuary where the animals all lived in a large group. Observers assessed the personality traits, animals' attitudes toward other animals, and animals' attitudes toward humans using a calibrated-line method and eight pairs of contrary adjectives (e.g. calm-nervous). Two factors emerged: "obduracy" and "vivacity." Furthermore, when a donkey was moved into its new foster home it appeared more outgoing. One explanation for this change was that in foster homes the animals faced less social intimidation. However, the change in their environment did not seem to affect their attitude towards people and other donkeys, which indicates stability within their prominent personality traits. These results demonstrate the utility of understanding individual differences in personality in animals in that in this situation assessing personality helped match donkeys to compatible homes. For example, donkeys with high "vivacity" ratings seemed to like people more, whereas donkeys with a low "obduracy" score seemed to like dogs more.

Another study examined anxiety and fear of novelty in young pigs (Andersen et al., 2000). For this study, a total of 84 pigs were placed in four experimental testing situations in which their behaviors were coded. Their first test was for tonic immobility at 2.5 weeks of age. For this testing situation, the subject was placed on its back in a small cradle. While in the cradle, the pig was restrained for 5-10 seconds by a sand-filled cloth bag placed on its chest. Once the subject was released by the experimenter, the time it took the pig to attempt an escape was

recorded. The results from these experimental testing situations suggested most of the behavioral responses contained an element of fear and activity and that there were individual differences between subjects.

An especially interesting study examined the relationship between hair whorl patterns and temperament of breeding cattle (Grandin et al., 1995). Grandin et al. (1995) rated 1500 heifers and steers on a 4 point temperament scale while the animals were restrained in a squeeze chute during routine husbandry behaviors. The ratings used were: "1, calm, no movement; 2, restless, shifting weight; 3, head throwing, squirming and occasionally shaking the squeeze chute; 4, violently and continually shaking the squeeze chute" (Grandin et al., 1995, p. 118). Cattle with a round hair whorl pattern above their eyes were rated as being more agitated while in the squeeze chute than cattle with a hair whorl located either below or between eyes. This study implies a genetic component to personality in cattle.

Non-mammals

Personality studies are not limited to mammals. An invertebrate, the octopus, has shown great utility as a model for individual differences in personality (e.g., Mather & Anderson, 1993). Researchers have also investigated personality in fish, birds, reptiles, amphibians, and insects (e.g. fish: Coleman & Wilson, 1998; Francis, 1990; Budaev, 1997; birds: Webster & Hurnik, 1990; Jones et al., 1991; Figueredo et al., 1995; Funk & Matteson, 2004; snakes: Herzog & Burghardt, 1988; newts: Halliday, 1976; butterflies: Gerould, 1927). For example, Budaev (1997) examined differences in the exploratory behavior and social tendencies of guppies. In his study, the fish were observed during four different situations: "open-field test," "predator inspection test," "schooling tendency test," and "mirror test." The results indicated individual differences in behavioral patterns. Under the novel situations (open-field and predator inspection), two personality dimensions emerged: exploratory and fear avoidant. Under the social situations (schooling tendency and mirror), two personality dimensions also emerged: sociability and locomotion. An interesting point made by the author was that the exploratory factor probably

played a role in the sampling procedure. He found that the most exploratory guppies were the first to be caught because they saw the fishing net as an interesting, novel object to be explored. This is a valid point to keep in mind when performing personality studies on wild-caught animals.

Another study examined personality traits in Zebra finches (Figueredo et al., 1995). For this study, the authors employed the rating method by using a modified version of the personality assessment scale previously used by Stevenson-Hinde and Zunz with macaques. Figueredo et al. (1995) assessed the validity of the measure, the stability of traits over time, and inter-rater reliability. Zebra finches showed the following personality traits: sociable, excitable and confident. Because the findings were high on measures of validity, stability of traits over time, and inter-rater reliability, this study indicated a strong success in using similar personality assessments across different species.

CHAPTER III

SPECIES CHOICE: GARNETT'S BUSHBABIES (*OTOLEMUR GARNETTI)*

General Information

The species to be examined in the current study is Garnett's bushbaby (*Otolemur garnettii).* Bushbabies are naturally found in east Africa ranging from southern Somalia to Tanzania, as well as the island of Zanzibar (Bearder et al., 2003; Groves, 2001). Their tropical habitat consists of canopies in coastal and highland forests (Bearder et al., 2003). This small species ranges in weight from 721 to 822 grams and 230 to 338 mm in body length (Rowe, 1996). Males are slightly larger than females with adult males weighing an average of 794 grams and females weighing and average of 734 grams (Fleagle, 1999). Both males and females become sexually mature at approximately 20 months. Bushbabies are promiscuous and mating can last as long as 120 minutes. Mating can occur throughout the year, however in the wild, breeding occurs once a year, usually sometime between August and October (Rowe, 1996). In bushbaby populations under human care, females can give birth throughout the year (Masters, Lumsden, & Young, 1998). The gestation period is approximately 130 days and single births usually result (Rowe, 1996). Females provide all of the parental investment and weaning usually occurs approximately after 140 days (Rowe, 1996).

In the wild, bushbabies are nocturnal and arboreal. Males disperse from their birth territory, whereas females remain in their natal areas (Nash & Harcourt, 1986). Both sexes do not have ranges that overlap with same-age individuals. Their fruit-diet might be the reason for their lack of sociality because it is beneficial to exclude non-related individuals from areas where fruits are accessible (Nash & Harcourt, 1986).

Bushbaby Behavior

Females are the dominant sex and adult males seem to follow adult females more often when in housed under human care (Hager & Welker, 2001). Furthermore, captive female bushbabies have been observed acting aggressively towards novel males (Hager & Welker,

2001). Although, this species is semi-solitary, friendly social interactions do occur between members of the same-sex and opposite sex usually in areas where ranges overlap (Nash & Harcourt, 1986). Grooming and play behaviors are demonstrated by both males and females (Nash & Harcourt, 1986). Social play behaviors include chasing, tail pulling, wrestling, pouncing and non-aggressive biting (Price et al., 1999). Infant bushbabies display these play behaviors as soon as they are born (Price et al., 1999). Juvenile and adult bushbabies visually investigate novel objects using a head cocking behavior. Head cocking is performed more often by juveniles and seems to occur more when investigating an animal stimulus than an inanimate object (Cantalupo et al., 2002). Furthermore, head cocking occurs more often to novel stimuli (Rogers et al., 1993). An individual can also demonstrate aggressiveness with cuffing (Tandy, 1976). For this behavior, an individual uses its hand to slap another conspecific. The sender usually has its mouth open and stands in a bipedal stance while performing the behavior.

Both sexes often use vocal communication. These vocalizations have been grouped by their function: alarm calls, sex calls, distress calls, and infant click calls (Rowe, 1996; Becker et al., 1998). For example, the alarm call, which can last for an hour, can sound like a variety of noises including a rattle, whistle, knock, chirp, etc. (Estes, 1991). Whereas, a distress call is a high-pitched yell noise that is produced in response to fear or pain (Estes, 1991). A sex call is only produced by males and is emitted before and after grooming (Estes, 1991). There are a few infant-type calls including the infant click call, the infant growl call, and the infant humming call. During the first few weeks of life, an infant will develop the click call which it produces to elicit contact from its mother (Becker et al., 1998; Estes, 1991). Researchers believe that bushbabies also use foot-rubbing for communication by rubbing their feet against another material, such as a tree branch (Hager, 2001). Foot-rubbing is not distinct from background noise, researchers hypothesize that they can use foot-rubbing for communication without alerting predators (Hager, 2001).

Bushbabies also use olfactory signals as another type of communication (Tandy, 1976). There are many variations for this communicative technique. Adult males and females rub the chest gland against tree branches to mark territory (Estes, 1991) and also engage in ano-genital marking by dragging the hindquarters across the ground (Tandy, 1976). Another source of olfactory communication includes urine-washing (Tandy, 1976), in which an individual will urinate on its hands and then paint the substrate or rub the urine on the bottom of its feet, which enables them to leave their scent on everything they touch. Females will also partake in rhythmic urination in which they urinate around a new area (Estes, 1991).

Because bushbabies are nocturnal, they often depend heavily on the use of olfactory and auditory cues. However this species can also use specific visual cues. In one such study, the social responses to observing novel mirror images were videotaped and coded for 45 bushbabies (*Otolemur garnettii*; Becker et al., 1999). The authors examined the frequency and duration of the social responses towards the mirror as well as the frequency and duration of social responses directed elsewhere in the testing area. Scent marking was the most observed behavior in response to the mirrors, especially by males. Their results also indicated that when the subjects were near to the mirror, they would orient themselves towards it and display a bipedal posture and threat gestures. Overall, the behavioral responses demonstrated by the subjects towards the novel mirrors support the idea that this nocturnal species is able to recognize conspecifics using visual cues only.

The above examples of bushbaby behavior demonstrate that these animals are capable of much variation in their behavioral repertoire, which suggests that consistent individual differences among bushbabies might reflect individual personalities.

CHAPTER IV

OVERVIEW OF ENVIRONMENTAL ENRICHMENT

Animal personality research is important for both practical and theoretical reasons. In particular, animal personality assessments can be of great value in creating individualized plans of environmental enrichment. Environmental enrichment is defined as an "animal husbandry principle that seeks to enhance the quality of captive animal care by identifying and providing the environmental stimuli necessary for optimal psychological and physiological well-being" (Shepherdson, 1998, p. 1). Environmental enrichment was formally introduced 80 years ago by Yerkes (1925) when he designed play items for the primates housed at his lab. His goal was to provide physical and behavioral stimulation to a relatively sterile environment. During the 1940's, Hediger (1950) examined the psychological needs of animals housed at the Zurich Zoo. Hediger (1950) believed that zoo exhibits should be constructed in a way that the animals are encouraged to exhibit natural behaviors (Luoma, 1987). Since these pioneering studies, many researchers and zookeepers around the world have recognized the need for environmental enrichment (see Shyne, 2006; Swaisgood & Shepherdson, 2005, for reviews). Furthermore in 1991, the organization "The Shape of Enrichment" was formed to help promote enrichment efforts worldwide. This organization also publishes a small journal which acts as an international forum for animal keepers to exchange enrichment ideas. Also, in 1993, Drs. Shepherdson and Mellen began the International Conference on Environmental Enrichment (ICEE) which is an international meeting chiefly concerned with enrichment and animal welfare. Demonstrated by its growing international interest, environmental enrichment has become a very relevant topic in animal behavior research.

Environmental enrichment is most often implemented within a zoo or laboratory setting to help reduce stereotypic behavior. Stereotypic behavior is defined as "repetitive, invariant behavior patterns with no obvious goal or function" (Mason, 1991, p. 1015). Some common examples of stereotypic behavioral patterns are pacing, fur or feather plucking, and excessive

licking (Mason et al., 2007). It has been suggested that these abnormal patterns of behavior occur for a number of reasons (Mason et al., 2007). One possibility is that the captive environment provokes either an internal or external state which persistently elicits a particular behavioral response. Another possibility is that the captive environment causes constant stress for the animal which affects particular regions of its brain, resulting in abnormal behavioral patterns. Finally, it has been suggested that an insufficient rearing environment causes lasting damage to the central nervous system and consequently results in stereotypic behaviors. Identifying stereotypical behavioral patterns is important for determining which environments are negatively affecting animal welfare (Mason et al., 2007). Due to this relationship between stereotypic behaviors and poor environments, many studies have examined the existence of stereotypic behaviors and tested possible ways to eliminate them. In their extensive review, Mason and colleagues (2007) estimate that at least 10,000 captive wild animals worldwide are affected by stereotypic behavioral patterns.

When a zoo or laboratory addresses the problem of stereotypic behaviors, five broad solutions can be attempted: genetic selection, pharmacological compounds, positive reinforcement for alternative behaviors, punishment of stereotypical behaviors, and environmental enrichment (Mason et al., 2007). Out of these five choices, environmental enrichment is the most often implemented, and therefore numerous studies examining the effectiveness of different enrichment strategies have been done with a variety of species.

CHAPTER V

REVIEW OF LITERATURE ON ENVIRONMENTAL ENRICHMENT

Overview

Swaisgood and Shepherdson (2005) reviewed 13 years of published data from peer-reviewed journals and found 25 publications which met the experimental and statistical standards necessary for meta-analysis. From this analysis, they found that environmental enrichment was associated with significant decreases in stereotypic behaviors approximately 53% of the time. While this percentage seems rather convincing, Shyne (2006) suggested that Swaisgood and Shepherdson's results were not completely accurate. She explained that Swaisgood and Shepherdson's vote-counting method can under-appreciate the magnitude of the effect, so she took a different approach to her own meta-analysis of environmental enrichment research. She first encoded the magnitude of each relevant statistical relationship found in the enrichment literature and then compiled the effect size statistics (Shyne, 2006). Her analysis included 54 studies which yielded 63 effect size statistics. Ninety percent of the 63 effects sizes went in the predicted direction, which indicated that animals produced less stereotypic behavior when exposed to environmental enrichment than in the baseline condition. Shyne's (2006) results strongly support the notion that environmental enrichment has a positive influence on the behavioral patterns of captive zoo animals.

Recently, de Azevedo and colleagues (2007) took yet a third approach to assessing the scientific research in the area of environmental enrichment. The goal of their review was to simply organize what has been done in the field of enrichment, without focusing on the minutiae of statistics. Using the database, Web of Science©, they found 744 acceptable abstracts published between 1985 and 2004. From these, they extracted 15 pieces of information:

> (1) year of publication; (2) environment where animals were maintained (i.e., zoo, laboratory, farm and ''other'' (pets or human studies)); (3) type of article (e.g., experimental, review, abstract, etc.); (4) number of experimental animals used; (5) number of experimental groups (i.e., statistical replicates); (6) addresses of authors (by country); (7) taxonomic classification (i.e., mammal, bird, fish, reptile, amphibian and

> invertebrate); (8) type of enrichment (i.e., food, structural, social, sensory (e.g., use of music), cognitive (e.g., use of puzzle boxes), various and unknown); (9) species and zoological order; (10) subject area of article (e.g., neurosciences, zoology, veterinary sciences, behavioural sciences, agriculture, etc., as classified by The Web of Science©; (11) name of the journal (with its impact factor in 2003); (12) language of the publication; (13) number of citations received; (14) how animal well-being was measured (i.e., behaviourally, physiologically, neurologically or various); (15) whether the experiment was reported as a success (i.e., yes, no and equivocal) (de Azevedo et al., 2007, p. 331).

One of their findings was that the majority (69.51%) of experimental enrichment studies are conducted with laboratory animals, whereas farm animals and zoo animals made up 15.70% and 9.45% of the enrichment studies, respectively (de Azevedo et al., 2007). Accordingly, laboratory animals (rodents: 53.0%; monkeys: 16.4%) were the most frequently studied subjects, followed by pigs (5.29%) and chickens (5.15%). They also evaluated the different ways in which the effects of environmental enrichment were assessed. The majority (53.54%) of studies examined the effects of enrichment through changes in animal behavior, such as time budgets. The second most popular dependent variable was neurological assessment, such as dendrite density (35.10%), and the third most popular dependent variable was physiological measure, such as measuring corticoids (8.55%). Most importantly, they found that 64.78% of researchers reported that their environmental enrichment techniques did improve the well-being of their subjects (de Azevedo et al., 2007). They encountered a variety of enrichment types within the literature including: structural (e.g. adding furniture or toys), sensory (e.g. adding a new smell), social (e.g. changing social grouping), food related (e.g. hiding food), cognitive (e.g. puzzles) and a combination of various types. Their limited means of analysis did not allow them to deduce which enrichment type had the most success. However, their article provided an outline of progress in the area of environmental enrichment over the last 20 years. Their findings indicate that the five basic types of enrichment most commonly implemented have differing rates of success in reducing the incidence of unwanted behaviors.

Structural Enrichment

One of the easiest environmental enrichment techniques is to provide the animals with objects that they can manipulate. One such study examined the effects of manipulable objects on the presence of abnormal behaviors in various bear species (Altman, 1999). For this study, the experimenter provided plastic floats to two polar bears and plastic balls to a sloth bear and a spectacled bear. Behavioral observations were made using a continuous sampling procedure for each of the four subjects. Each subject was observed for a total of 95 hours over a 28-day period. For the analyses, baseline behaviors were compared to behaviors observed during enrichment exposure. During the testing period, the polar bears almost doubled their activity levels when provided the toy floats. The spectacled bear decreased its stereotypical pacing behavior by half when provided the plastic balls. However, the sloth bear did not respond to the enrichment items. Overall, this study supported the notion that structural enrichment is beneficial to captive bears. However, it may be noteworthy that the benefits of the intervention did not apply equally to all four subjects.

A different study examined the effects of structural environmental enrichment on the behavior of seven harbor seals and two grey seals (Hunter et al., 2002). For this study, behavioral observations of the seals were made with and without the presence of five enrichment devices: a PVC sculpture, a grass bed, a bubble net, a crate structure, and a floating platform. Each seal was observed with each enrichment device separately. The results indicated that pattern swimming decreased and random swimming increased when enrichment items were present. Also, the amount of time the seals spent exploring increased when enrichment items were in their pool. Specifically, the seals increased their activity the most when the bubble net was present, followed by the PVC sculpture and floating platform. Overall, Hunter and colleagues (2002) found that structural enrichment benefits harbor and grey seals by reducing stereotypic behaviors and increasing activity levels.

One study examined the effects of adding "furniture" to an exhibit housing two spectacled bears (Renner & Lussier, 2002). Observations of the bears were made for 40 hours using a detailed ethogram. Both cage location and behavioral activity were recorded. Baseline data indicated that the bears spent the majority of their time in limited areas of their enclosure and exhibited a small number of behaviors. During the experimental phase, a large climbing structure was placed in the exhibit. The following observations indicated that the bears increased their overall use of the enclosure and performed a wider variety of behaviors. For example, both bears decreased the amount of time they spent engaged in a motionless, eyes-open behavior. Thus, structural environmental enrichment can serve as a very beneficial, yet fairly simple enrichment option.

Food Related Enrichment

Another common approach to environmental enrichment is providing animals with a wide variety of food items and feeding methods. The goal of this method is to stimulate natural foraging behaviors. One such study examined the effect of food related enrichment on the behavior of nine large felids (seven leopards, two lions; McPhee, 2002). For this study, behavioral observations were conducted during a baseline period in which the animals were fed a traditional processed diet and during an experimental period in which the animals were fed an intact calf carcass. Overall, the behavioral observations indicated that carcass provision increased feeding behavior in the cats, but there were individual differences. For example, while most of the cats increased their feeding behavior there was one individual who significantly decreased its feeding behavior in response to the carcass. Individual differences also played a role in the amount of stereotypic behaviors displayed after the introduction of the enrichment. Only one cat experienced both a significant increase in natural behaviors and a significant decrease in stereotypic behaviors, whereas two cats significantly increased natural behaviors, without decreasing stereotypic behaviors, and one cat significantly decreased stereotypic behavior without

increasing natural behaviors. (McPhee, 2002). This study demonstrates how individual differences can influence the effectiveness of an enrichment intervention.

Zimmermann & Feistner (1996) used food related enrichment in an effort to reduce aggression between ruffed lemurs and ring-tailed lemurs during feeding times. During the baseline feeding periods, food was spread on the ground and on tree stumps. During the experimental periods, food was placed in mesh baskets hung from the trees within the enclosure. The two feeding methods were alternated for 22 days. Behavioral observations of activity were made in between the feeding periods and observations of aggression were taken during feeding times. Overall, the results indicated a decrease in aggression between the two species when fed from the hanging baskets. Furthermore, ruffed lemurs increased their activity levels on days in which they were fed experimentally compared to days when the standard feeding method was used.

Another study investigated the effects of feeding enrichment with three captive African elephants using an ABA design (Stoinski et al., 2000). During their 2 baseline periods, the elephants were fed their normal diet of 59 kg of hay, 5 kg of grain and 4 to 5 kg of produce. During the treatment period, their morning hay meal was replaced with freshly harvested browse, including mulberry, bamboo, hackberry and oak species. The rest of the husbandry routine remained unchanged. Behavioral observations were conducted during the baseline and treatment periods. Their results indicated that the elephants spent significantly more time manipulating their food (i.e., amount of time feeding increased from 50% to 80%) during the treatment period. The increase resulted from the longer handling time needed to manipulate the browse for eating. Furthermore, during the treatment period, the percentage of time the elephants spent drinking and inactive significantly decreased. Overall, providing food related enrichment can serve as a simple and naturalistic method for increasing species-typical behaviors, and therefore successfully enrich environments.

Sensory Enrichment

More recently, environmental enrichment has started to include more sensory-focused items such as odors, sounds, and tactile stimulation. For example, one study examined the effect of olfactory enrichment on the behavior of captive black-footed cats (Wells & Egli, 2004). Six cats were exposed to four different odors: a "no-odor" control, nutmeg, catnip, and body odor of prey. A cloth saturated with a particular odor was placed in the subjects' home cage every morning for five days. Using a scan-sampling technique, behavioral observations were taken every five minutes for four hours. Seven behaviors were examined: resting, standing, sitting, moving, grooming, exploring pen, and exploring cloth. The results indicated that the three experimental odors significantly influenced the cats' behavior. Specifically, there was an increase in active behaviors and a decrease in sedentary behaviors. However, the cats habituated to the odors over the five day study period; therefore, when using odors as an enrichment tool, keepers should vary the odors used.

A similar study examined the effect of novel scents on the behavior of three captive-born lions (Schuett & Frase, 2001). Five scents (cinnamon, chili powder, ginger, zebra dung and human odor) were positioned in three locations around the lion enclosure. A variety of behaviors, including responses to the scent and interactions with other lions, were measured. The results indicated that exposure to novel scents significantly increased the activity levels of the lions, as well as social interactions between the lions. Not surprisingly, the scent with the most effect was the zebra dung.

Keepers at the Menominee Park Zoo in Wisconsin provided enhanced tactile enrichment by making heavy barrels available to American bison (Steele & Charley-Johnson, 2000). The bison quickly learned to push the barrel with their heads and would sometimes charge at it. This activity provided the bison an outlet for their natural head-butting behavior. At the Houston Zoological Gardens, zookeepers used auditory enrichment for a group of elephants (Melo, 1999). The elephants were provided with various musical instruments including a harmonica, a toy

electronic keyboard, a tambourine, and a cattle bell. These various instruments encouraged the elephants to use their trunks to manipulate objects, which is a necessary behavior in the wild. In general, sensory enrichment techniques can serve as a creative, novel, and cost-effective way to enrich the environments of captive animals.

Social Enrichment

It is rarely possible for captive animals to live in social groups similar to the ones they would maintain in the wild. However, for the well-being of captive animals, it is important to understand the species' natural social groupings and, when possible, house the animals accordingly. For example, a recent study examined the effect of different social housing conditions on the behavior of captive tigers (De Rouck et al., 2005). For this study, the experimenters examined the behavioral activities of tigers that were pair-housed and singly-housed. Their results indicated that tigers that were paired exhibited a wider variety of behaviors than tigers that were housed singly. The experimenters also examined differences in behavioral activity between pair-housed tigers with and without neighboring tigers (i.e., animals they could see, but not directly interact. Tigers with neighbors, exhibited more stereotypical pacing than tigers without neighbors, suggesting that the visual presence of other tigers may cause stress in the animals.

Social housing conditions may also influence the effectiveness of inanimate enrichment items for rhesus monkeys (Schapiro et al., 1996). The behavior of 49 control rhesus monkeys was compared with the behavior of 44 enriched rhesus monkeys that spent successive years housed singly, paired and in small groups. Subjects living in pairs and in groups spent more time playing and less time self-grooming and exhibiting abnormal behaviors than subjects housed alone. However, the presence of manipulable items did not influence behavior in any of the three housing conditions. Therefore, for this study, social enrichment was the best method for increasing species-typical behaviors and decreasing abnormal behaviors. Overall, these studies

suggest that placing animals in acceptable social groups can be used to provide environmental enrichment to captive animals.

Cognitive Enrichment

To date, cognitive enrichment has been only been provided to a few species, yet it has produced one of the highest success rates when compared to other types of enrichment (de Azevedo et al., 2007). Although some zookeepers may feel that cognitive enrichment is reserved for more intelligent species such as primates or cetaceans, all wild animals face challenges in their environment. Thus, cognitive enrichment has the potential to enrich many different species (Meehan & Mench, 2007). For example, Puppe and colleagues (2007) examined the effects of cognitive enrichment on domestic pigs. Using classical and operant conditioning, a group of pigs was trained to use a computer-controlled call-feeding-station (CFS; Ernst et al., 2005). The pigs had to recognize their individual acoustic call and go to the feeding system when the call was played. Once the subjects were trained on using the CFS, behavioral observations were made of both the trained pigs and control pigs (which were fed with a conventional feeding method; Puppe et al., 2007). Subjects fed with the CFS demonstrated significantly more "locomotor" behavior than control subjects. Furthermore, the experimental subjects demonstrated significantly fewer belly-nosing behaviors – a behavior thought to be abnormal. Overall, the challenging feeding system seemed to provide an enriching environment for these domestic pigs. The improvements in behaviors may be related to a perception of environmental control associated with the use of the CFS.

Even invertebrate species may be enriched by cognitive devices, as with a group of octopi at the Cleveland Metroparks Zoo that were presented with "prey puzzles" (Rehling, 2000). These devices were introduced to encourage natural investigative hunting behavior by the octopi. For example, one puzzle consisted of a plastic sphere with a moveable lid attached by elastic bands. A prey item was placed inside the plastic sphere and the octopus had to manipulate the lid to find a weak spot to open the sphere and then hold down the lid while retrieving the prey item.

"Prey puzzles" significantly increased the activity levels of the octopi. Rehling had to continually increase the complexity of the puzzles because the octopi were able to solve the puzzles with much ease. However, he noted that there were substantial individual differences in the rates with which the octopi learned the puzzles. In addition, the larger (older) octopi would often hold onto and inspect the object after the food had been retrieved. In fact, one elder male would sometimes dismantle the puzzle and hold onto a couple of the pieces for a whole day or longer. Taken together, these studies provide compelling evidence that cognitive enrichment can stimulate many species by providing both novelty and challenge.

CHAPTER VI

INDIVIDUAL DIFFERENCES WITHIN ENVIRONMENTAL ENRICHMENT

Many zoos and laboratories worldwide provide enrichment devices to their animals. These devices are usually meant to diversify the behavioral repertoires of *all* the animals housed within a certain exhibit or laboratory. However, animal caretakers all "have experiences with the idiosyncrasies of animals even within a species, where enrichment works well for some individuals but not for others" (Swaisgood & Shepherdson, 2005, p. 515). While one solution would be to broaden the enrichment technique to attract all animals, another solution could be to tailor particular enrichment techniques for specific animals based on their individual personalities. In fact, at the recent International Conference on Environmental Enrichment a prevalent discussion among many animal caregivers focused on the need to consider animals as individuals because of the importance of individual differences (de Azevedo et al., 2007). This issue was also addressed in an article featured in *The Shape of Enrichment* which examined the effect of enrichment items tailored for individual pandas (Bacon et al., 2000). In their article, they explained that their two adult pandas have personalities that "are as different as night and day" (Bacon et al., 2000, p. 1). They describe the panda Bai Yun as energetic and confident, yet easily bored, whereas they describe Shi Shi as reserved and finding little interest in objects besides food. With these differences in mind, the authors developed separate enrichment goals for each animal based on their individual needs. For Bai Yun, they wanted to alleviate her boredom with a source of mental stimulation. They also wanted to elicit more natural behaviors in an effort to prevent the development of stereotypic behaviors. The goals for Shi Shi were different in that they wanted to increase his exploratory behavior by encouraging an interest in his surroundings and specifically decreasing his wandering and door-directed behaviors. Furthermore, Shi Shi is an older male, so they wanted to provide physical exercise to help with his muscle tone. For their study, they began by providing both pandas with the same types of enrichment (e.g. heavy scatter of food, frozen ice blocks with food, bamboo puzzle feeders) and then modified them according

to their specific needs. The pandas showed marked differences in their responses to the same enrichment items. For example, Shi Shi was not interested in the frozen ice blocks with food. He would only briefly paw at the blocks and then leave the area, whereas Bai Yun would interact with the ice blocks for extended periods of time by biting, chewing and manipulating the block to retrieve the food inside. She nearly doubled her normal foraging time, which helped with alleviating her boredom. Another enrichment technique used in this study was "heavy scatter" which involved simply hiding food throughout the enclosure. This technique worked very well for Shi Shi. He dramatically extended his foraging time, which increased his exploratory behavior and decreased his wandering and door-oriented behaviors. However, the heavy scatter technique was not as successful with Bai Yun because she would quickly stop looking for the hidden food items and begin eating readily available bamboo.

Based on the individual preferences, the authors were able to modify the enrichment techniques which worked best for each panda (Bacon et al., 2000). For example, they provided Bai Yun with more complicated "bamboosicles" and larger 5 gallon ice blocks. Bai Yun responded very well to these modifications. The authors also modified the heavy scatter technique for Shi Shi. They hid the food items in less obvious places such as on top of a cave and under rocks and logs. Shi Shi was still able to find the food items while also increasing his exercise by moving logs and standing up to reach the top of the cave. This study exemplifies the importance of considering individual animal personalities when developing realistic enrichment goals and techniques.

Creating individualized enrichment plans is analogous to creating individualized education plans (IEP) for students with special needs. An IEP is designed to meet the unique educational needs of one child (Rodger, 1995). This individualization allows educators to better assist the child in reaching his/her personal goals. Similarly, individual animals have unique problems or preferences, and would greatly benefit from enrichment plans tailored specifically for them. Despite the need for individualized enrichment plans, testing multiple enrichment

options with all individuals of a large group would be very time-consuming and cost-prohibitive. A possible solution may be to assess the different personalities within the group and provide various enrichment interventions based on individual personalities. To test this possibility, the current study examined whether certain enrichment options match particular personalities.

For the proposed study, bushbaby personality was assessed using a rating instrument and behavioral codings. Human raters used a modified version of the human Five Factor Model scale to initially assess individual personalities. Individual personalities were also assessed using a series of behavioral tests. From these personality assessments, each subject was categorized as either being high or low in each of the five factors. Next, the subjects were exposed to five different enrichment interventions. Comparisons were then made to see if the effectiveness of each enrichment technique corresponded with the individual personality types. It was hypothesized that certain personality types were better suited to particular enrichment types. For example, animals who demonstrate high levels of Openness to Experience are curious and exploratory, so it was hypothesized that the enrichment interventions which provided opportunities for exploration and completely novel situations (heavy scatter, training, sensory items) would be more appropriate for these animals. Animals that are considered to be highly conscientious are more perseverant, so it was hypothesized that the challenging training sessions would be best suited for these animals. Furthermore, animals which are highly extraverted are more active, so it was hypothesized that enrichment interventions which provided more opportunity for exerting energy (heavy scatter, exercise area, sensory items) would be more suitable for these animals. It was also hypothesized that the conspecific area would be best suited for animals demonstrating high levels of agreeableness because these animals would be more affiliative and friendly. Finally, it was hypothesized that the sensory enrichment would be well-suited for animals which displayed high levels of neuroticism, because these animals are more uncomfortable and aggressive, and could possibly benefit from a more natural environment. The

goal of this study was to examine whether or not individualized plans of enrichment related to personality differences are beneficial to a prosimian species.

CHAPTER VII

METHODS

Subjects

Subjects consisted of 10 Garnett's bushbabies (*Otolemur garnettii*) housed at the University of Southern Mississippi's Laboratory for Prosimian Studies. All subjects were pair-housed with an opposite-sex conspecific. Cages measured approximately 61 cm W X 61 cm D X 152 cm H. The subjects were maintained on a 12:12 reverse light dark cycle, with dark onset at 8 am. They were fed *ad libitum* monkey chow (Purina, St. Louis, MO), fresh fruit, and water. The age of the subjects ranged from 2 to 15 years. All procedures were in compliance with state and federal guidelines.

Materials and Test Environments

Assessment of Personality Characteristics

Personality was assessed using a short rating instrument comprised of behavioral adjectives normally observed in bushbabies. All terms were operationally defined to encourage consistency in the raters' assessments. Specifically, the instrument utilized each of the Five Factor personality dimensions: Extraversion, Agreeableness, Conscientiousness, Neuroticism, and Openness to Experience (Goldberg, 1990). The Five Factor dimensions were chosen to provide a framework of possible personality characteristics and to encourage cross-species comparisons. The rating instrument contained 10 adjectives (2 for each dimension) which were scored on a 7-point rating scale, with 7 indicative of an extremely accurate description and 1 indicative of an extremely inaccurate description (see Appendix A). The order of the 10 adjectives was arranged randomly. Four independent raters used the personality measure to rate the subjects based on their overall impressions from interactions during daily animal care, veterinary procedures, and previous behavioral observations.

Personality was also coded during various experimental procedures. Two independent coders used the same 10-item personality measure to code the personality of the subjects during

10 specific situations, which reflected the behavioral adjectives from the measure. Two of the 10 behaviors were coded from live observations of the subjects. The remaining behaviors were coded from video-recorded behaviors.

A behavioral ethogram was used in examining activity levels and frequency of stereotypic behaviors in the animals' home cages (see Appendix B). In addition, behavioral observations were made in three separate, unfamiliar situations. Two of these occurred in a testing environment outside the bushbaby's home cage. For these two assessments, subjects were transported from the home cage to the testing area in a 48 cm W X 50 cm D X 53 cm H cm transport box. This box also served as a start box and was equipped at one end with a guillotine door and at the other end with an interior false wall to which a dowel rod was attached. The overhead lights were shut off in the testing room and illuminated with dim red light to mimic the homecage environment and to permit videotaping.

The first behavioral observation was conducted in an open field environment composed of a 61 cm W X 61 cm D X 152 cm H modified cage. The floor and three sides of the cage were lined with white vinyl sheeting. The fourth side was constructed with a clear Plexiglas window to accommodate videotaping. The ceiling was lined with mesh screening. The second of the behavioral observations was conducted in a Y-maze composed of two arms constructed from a 76.2 cm W X 50 D cm X 86.4 cm H modified cage. At the end of each arm was a small 48 cm W X 50 cm D X 53 cm H cage. The floor and three sides of the arms were lined with white vinyl sheeting. The third behavioral observation was conducted in the animal's home cage. For this assessment, the animal's interactions with a foraging device in the home cage were examined. The foraging device was a plastic ball with multiple openings (i.e., a wiffle ball), either with or without one of the openings enlarged sufficiently for the animal to insert its hand and remove a food object (e.g., a marshmallow).

Environmental Enrichment Interventions

Each subject was introduced to five different environmental enrichment interventions. The same 48 cm W X 50 cm D X 53 cm H cage was used to transport each subject from the home cage to the test room. As before, the testing room was illuminated with dim red light to permit videotaping. A modified version of the open field environment from the previous phase was used for one enrichment intervention. For this enrichment intervention, the open field was furnished with manipulable objects containing food items. In the second intervention, the subjects were placed in a 61 cm W X 61 cm D X 152 cm H cage that contained braches, swings, and other objects that were likely to afford opportunities for increased physical activity. A social intervention was also implemented in which the bushbabies were placed in a 61 cm W X 61 cm D X 152 cm H cage identical to the home cages. The final two enrichment interventions were provided in the subject's home cage. These required the introduction of a short plastic pole for training and a variety of manipulable objects (i.e., rattles, scented clothes, wood chips, etc.).

Procedure

Assessment of Personality Characteristics

Using the personality rating instrument, four independent raters who were knowledgeable of the individual bushbabies' behavior patterns rated the personality characteristics of the subjects from 1 to 7, with one indicating a very inaccurate description and seven indicating a very accurate description.

Personality characteristics were coded by two independent coders who observed the behavioral responses of the subjects during a set of experimental procedures and while in their home cages. The coders used the 10-item rating instrument to code bushbaby personality based on the experimental procedures and observations. The coders were instructed to simply watch the subject's behavior during the video provided or during home-cage observations, and then use the personality measure to judge the overall observed behavior. The ten behavioral adjectives examined are listed below.

Active. This dimension refers to the subject's activity level. Behavioral observations were made of each subject in its home cage. Activity level was recorded using a scan sampling method (Altmann, 1974). The behavioral ethogram was used to record behaviors. A total of four hours (eight 30-min sessions) of observations were made of each subject. Since all subjects were housed in pairs, both animals were observed simultaneously by trained observers. The eight 30-minute observations for each subject were randomly chosen between the hours of 0800 h and 1800 h. From these observations, activity budgets were created. The percentage of active behaviors (i.e. non-resting, non-stereotypic behaviors) was used to identify an individual's level of activity. Using the personality measure, two independent coders judged the subjects' activity/inactivity levels immediately following a 30-minute observation session.

Bold. This dimension refers to the subject's behavior in the face of a perceived threat. Leather gloves are always worn by laboratory technicians when handling the animals for veterinary procedures and experimental sessions. Personal observations have shown that these gloves elicit a stressful response (e.g. vocalizations, threat posture; laboratory observation). Therefore, for this experiment leather gloves served as a threatening stimulus. Each subject was placed into a start box for a five minute habituation phase. After five minutes, a guillotine door was raised allowing the subject to enter an open field area, and video recording began. The latency of the subject to enter the open field was recorded for a maximum of five minutes. Once the subject entered the open field, the guillotine door was shut. Eight leather gloves were arranged in the open field in front of and around highly rewarding food items (a small bowl of oranges with marshmallows and a small bowl of ravioli). The subject was allowed ten minutes to obtain the food items before being removed from the open field. If the subject did not obtain the food items during the session, the experimenter gave the food items to the subject once placed back in its home cage. Using the personality measure, two independent coders judged a subject's level of timidity/boldness after watching the first five minutes of video from bold experimental session.

Perseverance. This dimension refers to a subject's motivation to succeed, especially in spite of opposition or obstacles. Each subject was given a foraging device in its home cage. The foraging device was a plastic ball with multiple openings (a wiffle ball) with one of the openings enlarged sufficiently for the animal to insert its hand and remove a marshmallow. The subject was given 10 minutes to interact with the device and obtain the bait. All subjects were successful at obtaining the food item within ten minutes. Directly following, a similar foraging device was presented to the subjects. This foraging device was an identical plastic ball with multiple openings (a wiffle ball), but without one of the openings enlarged. A marshmallow was visible, but the bushbaby was not able to access it. After 10 minutes, the foraging device was taken from the subject and the subject was given the marshmallow by the experimenter. All sessions were video recorded. Two independent coders used the personality measure to judge a bushbaby's level of perseverance after watching the first five minutes of the video with the subject's interaction with the unsolvable foraging device.

Careful/Cautious. This refers to the degree to which a bushbaby exhibits care in its actions. For the experimental sessions occurring outside the home cage, each subject was placed in a start-box for a five minute habituation phase. After five minutes, a guillotine door was raised into experimental area. Videotaping began once the guillotine door was raised. The time it took the subject to leave the start box was recorded as its latency (maximum of five minutes). Using the personality measure, two independent coders judged the subject's level of carefulness after watching the video of a five minute latency period.

Affiliative. Affiliation refers to the extent to which the subject will seek out social contact with another animal. The Y-maze was used for this procedure. The small cage at the end of each arm contained either a conspecific or a stuffed toy monkey similar in size to a bushbaby. Each subject was placed into a start box for a five minute habituation phase. After five minutes, a guillotine door was raised into the Y-maze. Latency of the subject to enter the maze was recorded for a maximum of five minutes. From the open area, the subject was able to see both cages at the

end of each maze arm. The subject was given five minutes to explore both arms. Each subject was tested four times. A same sex conspecific choice was used 2 times and an opposite sex conspecific choice was used 2 times, independent of the subject's sex. In this procedure, the current cage-mate of the maze runner was not used as a conspecific choice. Also, the location of each choice was counterbalanced to avoid side-preference bias. All sessions were video recorded. Two independent coders watched the video from one y-maze session for each subject and judged the subjects on their level of affiliativeness.

Friendly. This refers to the propensity to interact with human caretakers from its home cage. A volunteer who was novel to the animals in that she had never been to the Prosimian lab prior to experiment attempted to elicit contact with the subjects. First, the volunteer stood outside the cage near to the subject. If the animal approached the volunteer, she tried to gently pet the animal. If petting was accepted, the volunteer rubbed the subject until it left the area. If the animal resisted or prohibited petting in any instance, the volunteer tried to pet the subject once more after the subject was in reach again. If the animal continued to resist contact or tried to bite the volunteer, the session would end. All interactions were videotaped. Using the personality measure, two independent coders watched the video of the volunteer interacting with the subjects and judged each animal for its level of friendliness.

Comfortable. The comfortable dimension refers to the extent to which a subject demonstrates behaviors indicative of anxiety. Behavioral observations using the ethogram were collected using an all-occurrence sampling method (Altmann, 1974). The frequency of stereotypic behaviors was assessed. Two independent coders judged the subjects' level of comfort immediately following a 30-minute observation session.

Aggressive. Personal observations have indicated that the bushbabies can exhibit aggression towards each other over a highly rewarding food item (laboratory observations). The trait of aggressiveness was assessed by examining whether the subject is aggressive towards a conspecific (e.g. displays a high frequency of biting, threat gestures, vocalizing, chasing, etc.)

when a highly rewarding food item is presented in the cage. One male and one female who were currently housed together were provided a solvable puzzle feeder (wiffle ball with enlarged opening) baited with marshmallows. The puzzle feeder was placed between the two subjects in their home cage. Their behavior was videotaped for ten minutes. Two independent coders watched the first five minutes of each recorded pair-interaction and judged each subject's level of aggressiveness using the personality measure.

Exploratory. This dimension examines whether the animal is inquisitive by the subject's propensity to explore novel environments. The open field area was divided into six equal areas using black electrical tape on the floor. Familiar and novel objects were placed randomly throughout the open field. A subject was placed into a start box for a five minute habituation phase. After five minutes, a guillotine door was raised allowing entrance into an open field area, and video recording began. The latency for the subject to enter the open field was recorded (maximum of five minutes). Once the subject entered the open field, the guillotine door was lowered. The subject remained in the open field area for ten minutes. Using the personality measure, two independent coders judged each subject on its level of exploratory/non-exploratory behavior after watching the first five minutes of the video recording.

Curious. This dimension examines the extent to which an individual interacts with unfamiliar or novel items or situations. The open field was sectioned off into two equal areas using black electrical tape on the floor. Familiar objects from the subject's home cage were placed in the section closest to the entrance and novel objects were placed in the other section. The subject was placed into a start box for a five minute habituation phase. After five minutes, a guillotine door was raised, allowing access into an open field area and video recording began. The latencies to enter the open field were recorded, with a maximum of five minutes. Once the subject entered the open field, the guillotine door was closed. Each subject's level of curiosity was judged by two independent coders who watched the first five minutes of the video recording. The novel side and the familiar side were indicated to the coders.

Environmental Enrichment Intervention

Upon completion of personality assessments, all subjects were exposed to five different enrichment techniques. The order in which the subject were exposed to each enrichment technique was determined using a Latin Square (see Table 1). Behavioral observations of the subject in its home cage were made from 0800-1000 h for two days prior to the enrichment intervention. This time period was chosen because for the bushbabies in this lab, 33% of stereotypy occurs during the initiation of the dark cycle (Hanbury, Watson, & Broach, 2007). After the two observation days, the subjects were introduced to an environmental enrichment intervention for 60 minutes per day for three consecutive days. Behavioral observations were again made of the subject in its home cage from 0800-1000 h for two days following the enrichment. A behavioral ethogram was used during these observations to assess frequency of non-stereotypic behaviors and stereotypic behaviors. Pre- and post-enrichment observations were compared to assess whether there was a decrease in stereotypic behaviors. The five enrichment interventions are described below.

Table 1

Environmental enrichment order based on Latin squares

Week	Heath	Marie	Fred	Sybil	Bub	Rosie	Moonstone	Piper	Joey	Brandine
1	H	H	E	E	T	C	S	S	C	T
2	T	C	C	T	E	E	H	H	S	S
3	E	E	S	S	C	T	T	C	H	H
4	C	T	H	H	S	S	E	E	T	C
5	S	S	T	C	H	H	C	T	E	E

H=Heavy Scatter, T=Training, E=Exercise Area, C=Conspecific Area, S=Sensory Enrichment

Heavy Scatter. For this enrichment technique, the subject was placed into a modified open field. Within the open field area, small food items were placed under toys, hidden in hanging baskets, placed in puzzle feeders, etc. The hiding spots were different for each of the three sessions to ensure variety.

Simple Training. For this enrichment technique, the subject was involved in training sessions that encouraged the bushbaby to touch the end of a small pole with its nose. Operant conditioning and, specifically, shaping were used in these training sessions. During the shaping procedure, the bushbaby was rewarded with small pieces of cereal. All training sessions took place in the animal's home cage. Cagemates were removed from the cage during the training sessions.

Exercise Area. The exercise area was a modified cage with many opportunities for exercise including branches, swings, hanging flowerpots, and rope ladders. For this enrichment technique, the subject was put into an exercise area for a total of 60 minutes per day for three days. The objects in the cage were rearranged for each of the three sessions to ensure variety.

Conspecific Area. This enrichment technique paired the subject with a conspecific different from his/her current cage-mate. For this enrichment technique, the subjects were transferred to a cage that was unfamiliar to both animals. The cage was comparable to home cages, including shelves for climbing. When the subjects were initially introduced, the pair was closely monitored to ensure that excessive aggression did not occur. None of the animals engaged in prolonged aggression, so no premature separations were needed. The subject was paired with the conspecific for 60 minutes per day for consecutive three days. After the session, the subject was placed back in his/her home cage with his/her original cagemate.

Sensory Enrichment. The aim of this enrichment intervention was to stimulate the subjects' senses in an effort to increase natural behaviors. In the bushbabies' natural environment they would encounter diverse smells, textures, tastes, and sounds, so for this technique, the subject was provided various sensory items such as scented cloths, rattles, hanging beads, air fresheners, plastic balls, and hidden food items in cedar shavings. This intervention was conducted in the animal's home cage and pair-housed subjects were provided the enrichment simultaneously. The subjects were provided these sensory-enhancing items for 60 minutes per day for three consecutive days. The objects were arranged differently on each of the three days.

Statistical Analyses

Interrater Reliability. Interrater reliabilities for each of the ten adjectives were assessed using intraclass correlation coefficients. Intraclass correlations coefficients (ICC) are a measure of consistency for a set of data when it has multiple groups (Müller & Büttner, 1994). Intraclass correlations were performed for both the raters' and coders' assessments of bushbaby personality. One of the four raters' responses was not useable due to a large amount of missing data. Therefore, the raters' information includes only the information provided by three of the raters.

Assessment of Personality Characteristics. Using the judgments based on the 30-minute live-observations and the five minute videos of the subjects during the experimental procedures, a composite score was created for each subject under each factor. Using the composite scores, median values were computed for each factor from personality codings. Also, scores from the personality codings were standardized to fit a normal distribution. The new z-scores were used to create personality profiles for each animal.

Environmental Enrichment Intervention. Decreases in behaviors following exposure to environmental enrichment were considered indicative of an effective enrichment intervention. Repeated measures ANOVAs were computed for each enrichment type.

Effect of Enrichment related to Personality Type. A median-split design was used to categorize each subject as either "high" or "low" on the five factors (MacCallum, Zhang, Preacher, & Rucker, 2002). See table 2 for predictions as to which enrichment types would be suited or not suited for particular personality types. A series of mixed model analysis of variance (ANOVA) was used to examine whether personality was related to the effectiveness of environmental enrichment with behavior change as the within subjects variable and group assignment as the between subjects variable.

Table 2

Hypotheses for which personality types were suited or not suited for particular enrichment types

Personality Type	Enrichment Type				
	Heavy Scatter	Training	Conspecific	Sensory	Exercise
Openness to Experience	Yes	Yes	No	Yes	No
Conscientiousness	No	Yes	No	No	No
Extraversion	Yes	No	No	Yes	Yes
Agreeableness	No	No	Yes	No	No
Neuroticism	No	No	No	Yes	No

CHAPTER VIII

RESULTS

Reliability

To test for inter-rater reliability between the three independent raters of overall bushbaby personality, intraclass correlation coefficients (ICC) were computed for each adjective. The ICCs for the ten adjectives ranged from 0.51 (friendly) to 0.81 (not exploratory) with a median of 0.63.

Inter-coder reliability between the two judgments from 5-minute videos and 30-minute live observations of experimental procedures was also assessed. The ICCs for the ten adjectives ranged from 0.74 (comfortable) to 0.99 (not exploratory) with a median of 0.94.

Assessment of Personality Characteristics

The rating method of personality assessment proved unreliable in this study whereas the coding method was highly consistent in characterizing bushbaby personality. Therefore, all further interventions and analyses were based on results obtained via the coding method.

An average score for each of the ten adjectives was computed for each subject. Two adjectives corresponded with each of the five factors: Extraversion: active (ICC =0.91) and timid (ICC = 0.81); Openness to Experience: curious (ICC = 0.97) and not exploratory (ICC = 0.99); Agreeableness: affiliative (ICC = 0.74) and friendly (ICC = 0.97); Conscientiousness: perseverance (ICC = 0.98) and careful (ICC = 0.83); Neuroticism: aggressive (ICC = 0.97) and comfortable (ICC = 0.74). An average score was computed for each pair of adjectives to create the composite score for each subject. Using a median-split, the composite score was used to categorize each subject as "high" or "low" under each factor (see Table 3). Also, composite scores were used to create personality profiles for each animal (see Figures 1-10).

Table 3

Subjects' high/low five factor categorization based on personality codings

	Extraversion	Openness to Experience	Agreeableness	Conscientiousness	Neuroticism
Joey	Low	Low	Low	High	Low
Brandine	High	Low	Low	Low	Low
Rosie	Low	Low	High	Low	High
Bub	High	High	High	Low	High
Moonstone	High	High	Low	Low	Low
Piper	High	High	High	High	High
Sybil	High	High	Low	High	Low
Fred	Low	Low	Low	High	Low
Heath	Low	Low	High	High	High
Marie	Low	High	High	Low	High

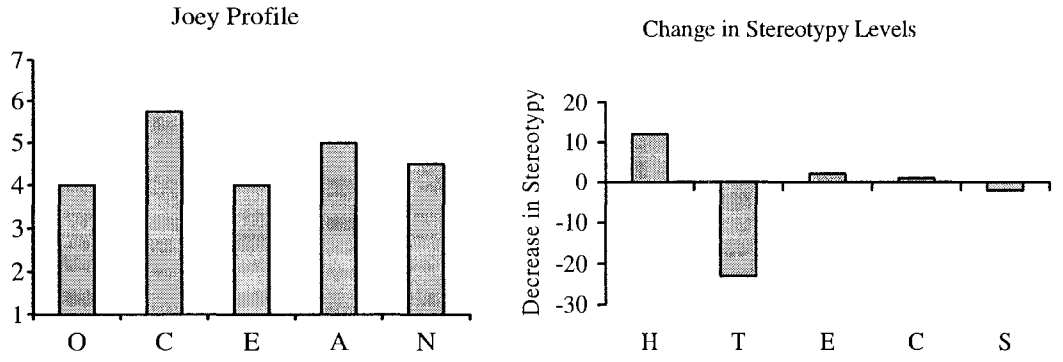

Figure 1. Joey's personality profile (O = Openness to Experience; C = Conscientiousness; E = Extraversion; A = Agreeableness; N = Neuroticism) and changes in stereotypy for 5 enrichment types (H = Heavy Scatter; T = Simple Training; E = Exercise Area; C = Conspecific Area; S = Sensory Enrichment).

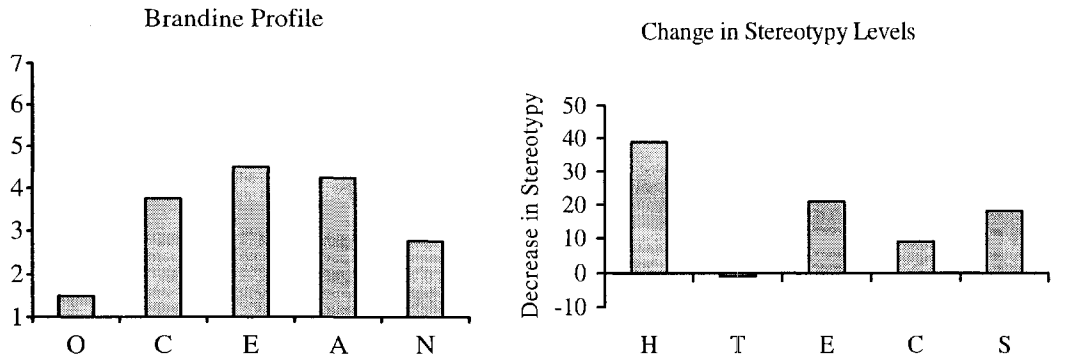

Figure 2. Brandine's personality profile (O = Openness to Experience; C = Conscientiousness; E = Extraversion; A = Agreeableness; N = Neuroticism) and changes in stereotypy for 5 enrichment types (H = Heavy Scatter; T = Simple Training; E = Exercise Area; C = Conspecific Area; S = Sensory Enrichment).

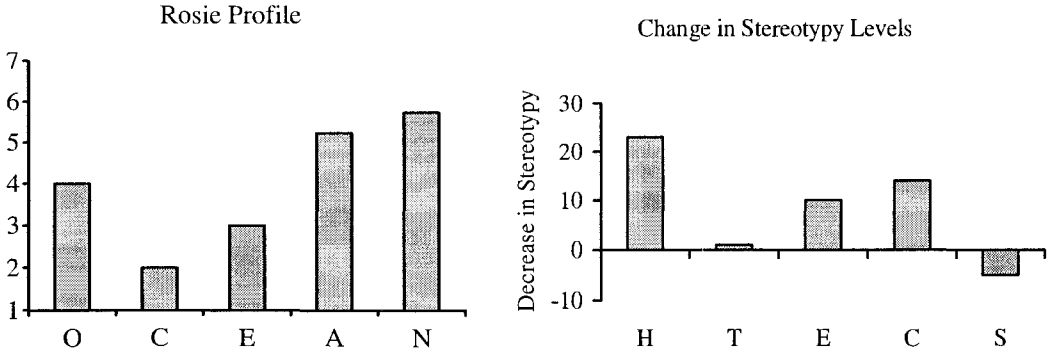

Figure 3. Rosie's personality profile (O = Openness to Experience; C = Conscientiousness; E = Extraversion; A = Agreeableness; N = Neuroticism) and changes in stereotypy for 5 enrichment types (H = Heavy Scatter; T = Simple Training; E = Exercise Area; C = Conspecific Area; S = Sensory Enrichment).

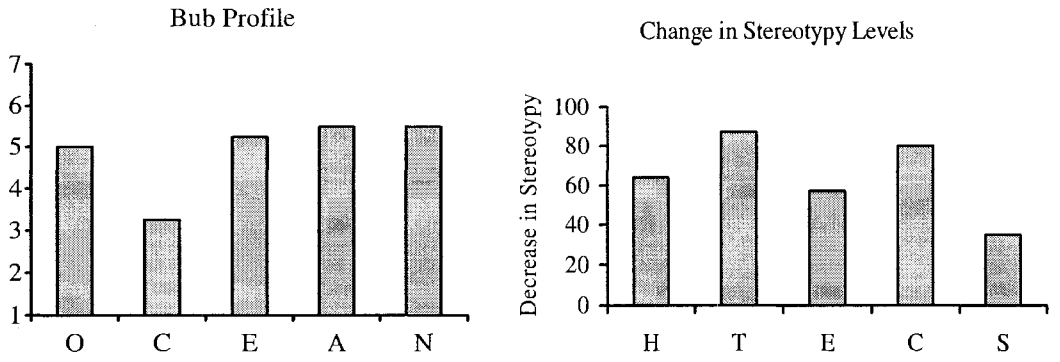

Figure 4. Bub's personality profile (O = Openness to Experience; C = Conscientiousness; E = Extraversion; A = Agreeableness; N = Neuroticism) and changes in stereotypy for 5 enrichment types (H = Heavy Scatter; T = Simple Training; E = Exercise Area; C = Conspecific Area; S = Sensory Enrichment).

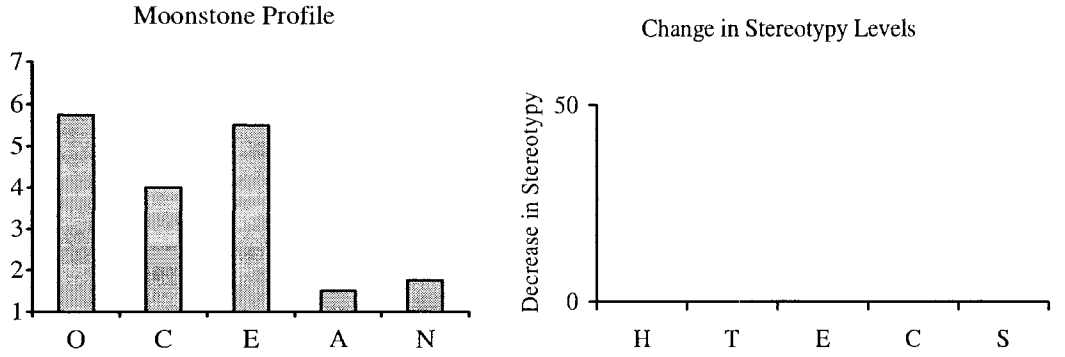

Figure 5. Moonstone's personality profile (O = Openness to Experience; C = Conscientiousness; E = Extraversion; A = Agreeableness; N = Neuroticism) and changes in stereotypy for 5 enrichment types (H = Heavy Scatter; T = Simple Training; E = Exercise Area; C = Conspecific Area; S = Sensory Enrichment). Note: Moonstone did not display any stereotypy during the observations within this study, he has been observed performing stereotypy in the past (Laboratory observations).

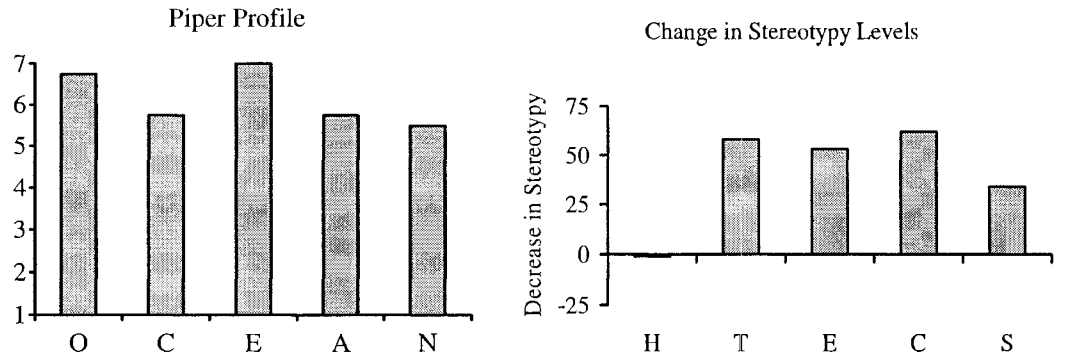

Figure 6. Piper's personality profile (O = Openness to Experience; C = Conscientiousness; E = Extraversion; A = Agreeableness; N = Neuroticism) and changes in stereotypy for 5 enrichment types (H = Heavy Scatter; T = Simple Training; E = Exercise Area; C = Conspecific Area; S = Sensory Enrichment).

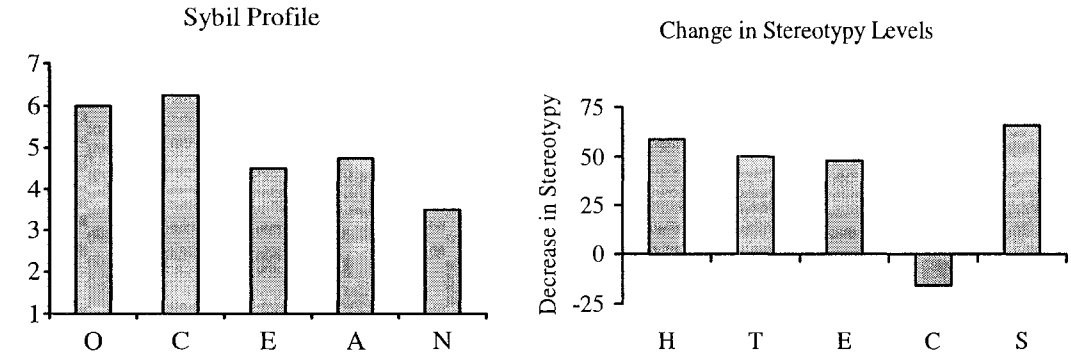

Figure 7. Sybil's personality profile (O = Openness to Experience; C = Conscientiousness; E = Extraversion; A = Agreeableness; N = Neuroticism) and changes in stereotypy for 5 enrichment types (H = Heavy Scatter; T = Simple Training; E = Exercise Area; C = Conspecific Area; S = Sensory Enrichment).

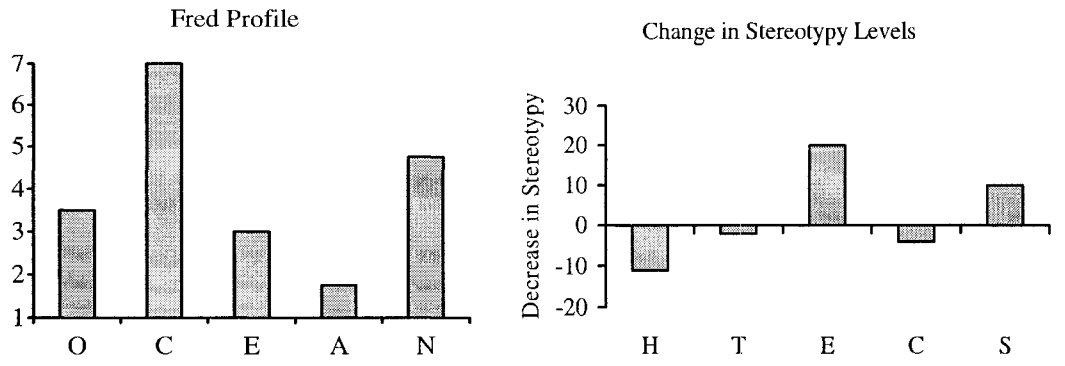

Figure 8. Fred's personality profile (O = Openness to Experience; C = Conscientiousness; E = Extraversion; A = Agreeableness; N = Neuroticism) and changes in stereotypy for 5 enrichment types (H = Heavy Scatter; T = Simple Training; E = Exercise Area; C = Conspecific Area; S = Sensory Enrichment).

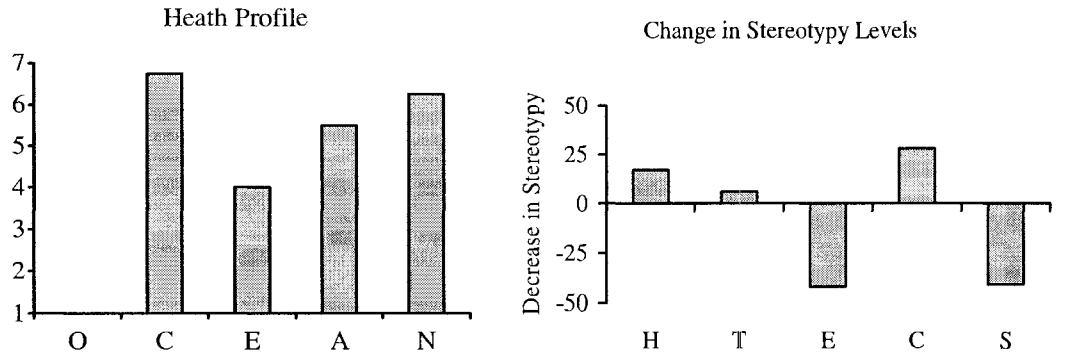

Figure 9. Heath's personality profile (O = Openness to Experience; C = Conscientiousness; E = Extraversion; A = Agreeableness; N = Neuroticism) and changes in stereotypy for 5 enrichment types (H = Heavy Scatter; T = Simple Training; E = Exercise Area; C = Conspecific Area; S = Sensory Enrichment).

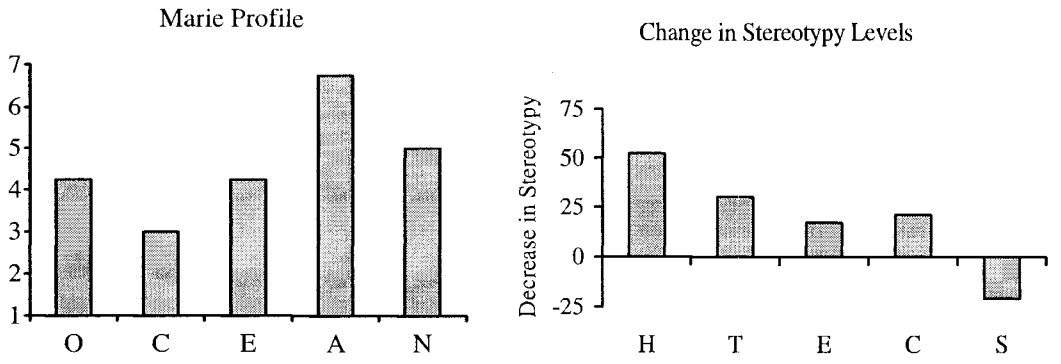

Figure 10. Marie's personality profile (O = Openness to Experience; C = Conscientiousness; E = Extraversion; A = Agreeableness; N = Neuroticism) and changes in stereotypy for 5 enrichment types (H = Heavy Scatter; T = Simple Training; E = Exercise Area; C = Conspecific Area; S = Sensory Enrichment).

Environmental Enrichment Intervention

Repeated Measures ANOVAs were performed to assess the overall efficacy of the enrichment strategies (see Table 4) and whether the enrichment interventions differentially benefited the animals based on personality type. The statistically significant findings are described below for each personality type.

Table 4

Results from repeated measures ANOVA tests examining the overall decrease in stereotypy after five enrichment strategies

Enrichment Type	Pre-Enrichment Mean (SD)	Post-Enrichment Mean (SD)	$F(1)$
Heavy Scatter	42.40 (38.03)	17.00 (23.51)	9.02*
Simple Training	38.40 (41.06)	17.80 (18.57)	3.58
Exercise Area	42.50 (41.82)	23.90 (24.46)	3.94
Conspecific Area	41.00 (49.32)	21.50 (27.33)	4.17
Sensory Enrichment	31.90 (39.76)	22.50 (22.21)	0.94

*$p < 0.05$

Openness to Experience: Bushbabies that were coded high on Openness to Experience exhibited decreased stereotypy after exposure to a simple training procedure ($F(1,8)=10.12$, $p = 0.01$, see Figure 11).

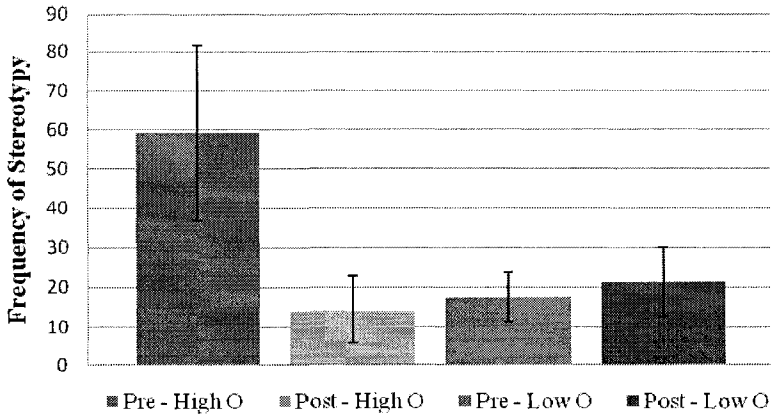

Figure 11. Stereotypic behaviors pre- and post-training enrichment for animals rating high or low on the factor of openness to experience (O; $F(1,8) =10.12$, $p = 0.01$).

Extraversion: Bushbabies that were coded as high on the factor of Extraversion, decreased levels of stereotypic behavior following the exposure to the exercise area ($F(1,8) = 4.79$, $p = 0.06$, see Figure 12) and the sensory enrichment ($F(1,8) = 9.14$, $p = 0.02$, see Figure 13).

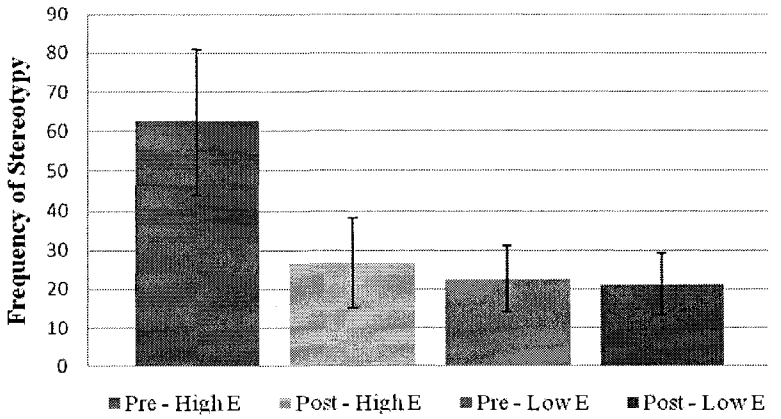

Figure 12. Stereotypic behaviors pre- and post-exercise area for animals rating high or low on the factor of extraversion (E; $F(1,8) = 4.79$, $p = 0.06$).

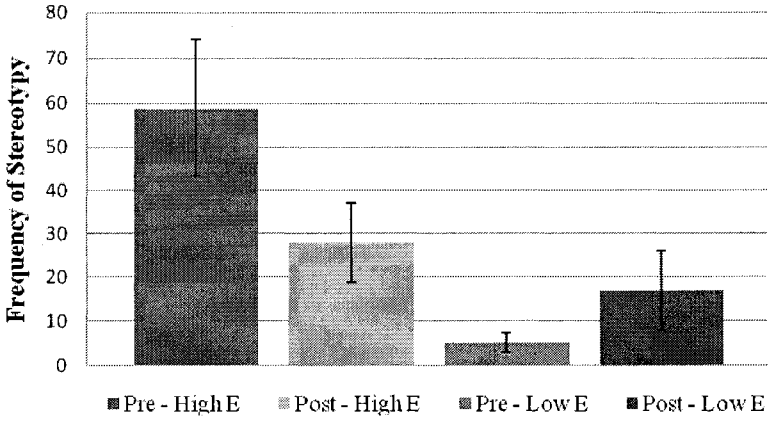

Figure 13. Stereotypic behaviors pre- and post-sensory enrichment for animals rating high or low on the factor of extraversion (E; $F(1,8) = 9.14$, $p = 0.02$).

Agreeableness: Bushbabies that were coded high on the factor of Agreeableness decreased their stereotypic behaviors after being paired with an unfamiliar conspecific ($F(1,8) = 10.29$, $p = 0.01$, see Figure 14).

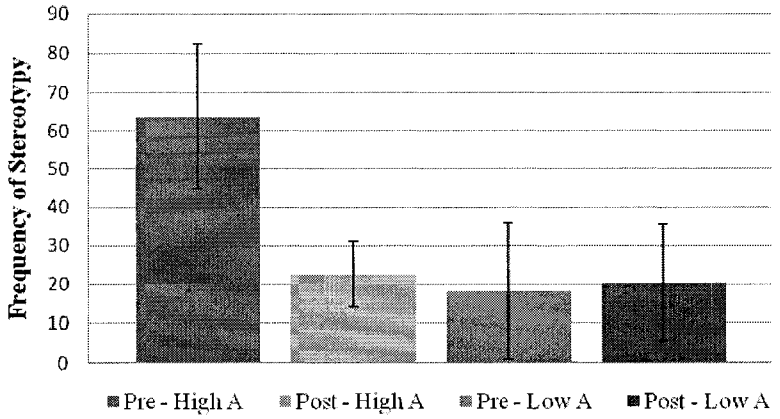

Figure 14. Stereotypic behaviors pre- and post-conspecific area for animals coded as either high or low on the factor of agreeableness (A; $F(1,8) = 10.29$, $p = 0.01$).

Neuroticism: Subjects that were coded high on the factor of neuroticism decreased their stereotypic behaviors after being paired with an unfamiliar conspecific ($F(1,8) = 10.29$, $p = 0.01$, Figure 15).

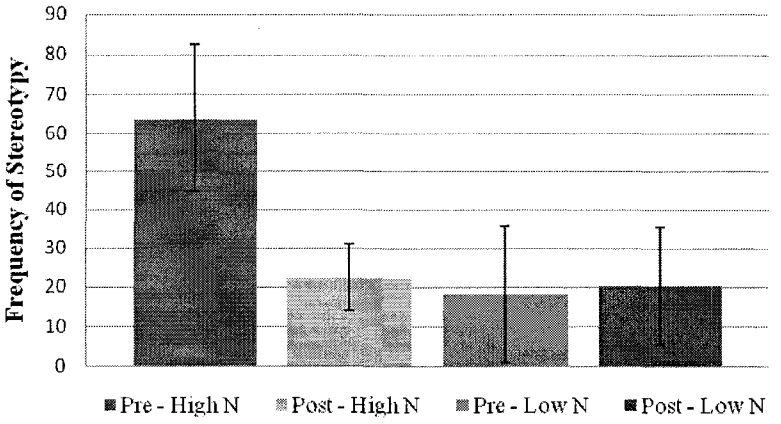

Figure 15. Stereotypic behaviors pre- and post-conspecific area enrichment for animals rating high or low on the factor of neuroticism (N; $F(1,8)= 10.29$, $p = 0.01$).

Overall, the hypotheses made for which personality types were suited or not suited for different enrichment types were significantly correct (binomial test: $p < 0.01$ in all cases, with 50% chance; see Table 5).

Table 5

Accuracy of hypotheses for which personality types were suited or not suited to enrichment types

Personality Type	Enrichment Type				
	Heavy Scatter	Training	Conspecific	Sensory	Exercise
Openness to Experience	Incorrect	Correct	Correct	Incorrect	Correct
Conscientiousness	Correct	Incorrect	Correct	Correct	Correct
Extraversion	Incorrect	Correct	Correct	Correct	Correct
Agreeableness	Correct	Correct	Correct	Correct	Correct
Neuroticism	Correct	Correct	Correct	Incorrect	Correct

CHAPTER IX

DISCUSSION

Personality in Bushbabies

In this study, a rating method was initially used to assess personality in bushbabies. The rating technique has been widely used among animal personality researchers to assess personality in a number of species (e.g. Capitanio, 1999; Gosling & John, 1999; Gosling, 1998). Briefly, this method involves a group of observers, who are well-acquainted with the animals, making judgments about an individual animal's characteristic behavioral traits (Vazire & Gosling, 2004). Several studies indicated that the rating method can be a reliable measure of personality when high levels of agreement occur between raters. Significant inter-rater reliability suggests that observers well-acquainted with the subjects can reliably use a particular adjective to describe animals in terms of personality. Based on previous animal personality research, it was hypothesized that the inter-rater reliabilities for the ratings of bushbaby personality would be significant. However, in the present study, the inter-rater reliabilities between the raters were not significant, indicating that the independent raters were not able to reliably rate bushbabies on ten personality characteristics. Because this method has been successfully used in other studies (e.g. Dutton et al., 1997; Gosling, 1998; Highfill & Kuczaj, 2007) this result was unexpected. A possible explanation for the discrepant finding may be that the animals in the present study had different histories with the individual raters. For example, one rater was frequently involved with both husbandry and veterinary procedures. On occasion, this rater would have to perform procedures that were uncomfortable for the animals (e.g. female estrous checks, treatment of wounds, and administration of medicines). A second rater's involvement with the bushbabies was largely limited to feeding. The third rater frequently used the catch gloves to transfer animals from their home cages to the testing area and to restrain them for non-invasive experimental procedures. Thus, the animals' behavior in the presence of these individuals may have been more reflective of their expectations of the interaction than of the animals' personality characteristics.

Using raters with different experiences or relationships with the subjects may represent an inherent flaw of the rating method. The rating method is an appealing choice for animal personality research, because it involves cooperation from humans, rather than animals. However, if the subjects react differently to different raters, a rating measure may not accurately describe the personality of an animal.

In the present study, a second method of assessing bushbaby personality, the coding method, was also employed. The coding method involves volunteers coding an animal's reaction within either a novel or familiar situation (Gosling, 2001). In contrast to the results obtained by the raters, reliability was significantly high between the independent coders. With this coding method, the subjects were not reacting to a person, but a situation. The coding technique is more behaviorally based than the rating technique, and may be the better predictor of personality characteristics. Because the rating method proved unreliable in this study, all interventions and analyses were based on the coding method alone.

To examine whether personality differences between individual bushbabies exist, a personality profile was created for each subject. Comparison of these profiles indicated that there was variation among the bushbabies in prevalence of personality characteristics. For example, whereas some of the bushbabies were rated high in extraversion, others were rated low, indicating that high activity levels are not simply a characteristic of this species, but rather more accurately characterize some animals than others. In addition, no two personality profiles were exactly alike, a finding that further supports the assumption of individual differences in personality among bushbabies. The personality profiles for each bushbaby are depicted in Appendix C.

Effectiveness of Enrichment

The goal of environmental enrichment is to increase the rate of species-typical behaviors in captive animals. Prior research has, for the most part, implemented enrichment strategies generically, exposing all animals to the same intervention (de Azevedo et al., 2007). A practical benefit of characterizing animals in terms of personality types is that the information can be used

to tailor intervention strategies to be maximally effective for a given individual. That approach was employed in the present study. The behavior most frequently studied in environmental enrichment research has been decreases stereotypic behaviors (e.g. Wells & Egli, 2004; Parker, et al. 2006). Thus, in the current study stereotypy was examined before and after exposure to the five types of environmental enrichment. All five enrichment interventions had a beneficial effect across subjects by decreasing stereotypic behaviors. Repeated Measures ANOVAs demonstrated that one of these changes was statistically significant. Specifically, the heavy scatter enrichment significantly decreased stereotypic behaviors. Overall, all five enrichments had a beneficial effect on the subjects, regardless of the personality type of the animal. Because Garnett's bushbabies frequently exhibit maladaptive behaviors in captivity (e.g., stereotypy, overgrooming), this finding may suggest a particularly effective component of the overall husbandry plan.

Effect of Personality on Enrichment Effectiveness

Analyses demonstrated that the five enrichment techniques differentially affected the subjects depending on personality type. For example, it was hypothesized that animals which were coded high on Openness to Experience would be well-suited for three types of enrichment: heavy scatter, sensory enrichment and training. This prediction was formed based on the adjectives used to describe Openness to Experience: exploratory and curious. The heavy scatter potentially encouraged exploratory behavior because the animals had to search for hidden food items. The sensory enrichment also potentially promoted exploratory behaviors, because the sensory items were scattered throughout the homecage. In addition, the heavy scatter, training, and sensory enrichments hypothetically catered to high levels of curiosity because the training situation, the heavy scatter food items and situation, and sensory items were completely novel to the subjects. The remaining enrichments were not entirely novel, because the animals are pair housed and have ways to exercise in their homecages. The results from the mixed model ANOVAs supported the hypothesis that the training enrichment was well-suited for animals demonstrating high levels of Openness to Experience. Before enrichment interventions,

bushbabies who were coded as being more open to experience exhibited higher frequencies of stereotypic behaviors than bushbabies coded as being less open to experience. Since animals that are high on the factor of Openness to Experience are more explorative and curious, they may be more susceptible to the stress of boredom, resulting in increased rates of stress related behaviors (i.e. stereotypic behaviors). After exposure to the training enrichment intervention, these animals demonstrated a decrease in their stereotypic behaviors. The intense novelty of the training sessions with human experimenters appeared to have relieved some of the monotony of captivity for these animals.

It was also hypothesized that the challenging training sessions would be well-suited for animals which were high on the factor of Conscientiousness, because these animals demonstrate high levels of perseverance. However, the data did not support this hypothesis. This could be due to the fact that the adjective of careful/cautious was also used to describe conscientious animals. Possibly, animals that are very careful were apprehensive about the novel interactions with the human experimenter. Since each animal was only exposed to three days of the training enrichment, it could not be determined if a decrease in the novelty of the situation would increase the benefits of this challenging task for perseverant subjects.

Additionally, animals which are highly extraverted are more active, so it was hypothesized that enrichment interventions which provided increased opportunities for exerting energy (heavy scatter, exercise area, sensory enrichment) would be more suitable for these animals. The results indicated that both the exercise area and sensory enrichment were well-suited for highly extraverted bushbabies. Subjects that were coded as being more extraverted produced more stereotypic behaviors before enrichment than bushbabies coded as being less extraverted. Because highly extraverted animals exhibit more active and bold type behaviors, they may be more susceptible to the stress of confined spaces, resulting in increased rates of stress (i.e. stereotypic behaviors). After being exposed to the exercise area, stereotypic behavior was normalized for highly extraverted animals. One might speculate that the extraverted animals

benefited from an outlet for excess energy which would typically manifest as stereotypic behavior. Similarly, the sensory enrichment also normalized stereotypic behaviors in highly extraverted animals. Possibly, the presence of sensory items scattered throughout the cage also provided these animals with more opportunities for exerting their excess energy. However, the heavy scatter did not exceptionally match with highly extraverted bushbabies. This outcome may be due to the heavy scatter set-up. Most food items were hidden below toys, within puzzle feeders and containers all lying on the floor of the open field area. This situation differs from the sensory enrichment and exercise area because it did not afford the animals as many opportunities for vertical movement such as climbing. Most likely, less energy was exerted within the heavy scatter area than the exercise area and sensory enrichment.

It was also hypothesized that the conspecific area would be best suited for animals demonstrating high levels of agreeableness because these animals are more affiliative and friendly. The results supported this idea, because after being exposed to an unfamiliar conspecific, stereotypic behaviors significantly decreased for highly agreeable animals. It may be that these more affiliative and friendly animals benefited from exposure to a bushbaby different from its normal cagemate.

Additionally, a hypothesis was made that the sensory enrichment would be best-suited for animals which displayed high levels of neuroticism, because these animals exhibit uncomfortable and aggressive behaviors. It was thought that these animals would find comfort in a more natural setting where all of their senses could be stimulated. However, this did not seem to be the case for this group of bushbabies. This discrepancy may be because the majority of sensory items used were not completely natural (e.g. scented cloths, beads, rattles). The effectiveness of this enrichment may have been increased with the presence of more natural items such as vegetation and running water. It is worth noting that animals who were high in Neuroticism exhibited higher levels of stereotypy before enrichment. This makes sense, considering one of the characteristics of Neuroticism is "uncomfortable" which was based on rates of stereotypy. Interestingly, being

paired with an unfamiliar conspecific helped to alleviate a significant amount of stereotypy for these animals. This finding is most likely related to these animals' level of Agreeableness, because the subjects that were high on the factor of Agreeableness were also high on the factor of Neuroticism. At first inspection, this finding seems counterintuitive. For example, it would seem that the adjectives friendly (Agreeableness) and aggressive (Neuroticism) would not be related, however friendliness was examined through reactions to humans and aggressiveness was examined through reactions to conspecifics. These two situations are very different for the bushbabies. For example, one of the most human-friendly bushbabies, Marie, is very accepting of human affection, but she demonstrated the most aggressive behaviors towards her cagemate. In addition, frequency of stereotypy was used in examining levels of comfort, and it was revealed that more agreeable animals display higher frequencies of stereotypy. Therefore, it is logical that for this study, Agreeableness and Neuroticism are related. In the future, different adjectives should be considered to assess Neuroticism in bushbabies. Moreover, future researchers may want to carefully consider the relevance of Neuroticism to bushbabies in general. It is quite possible that this factor is not appropriate for this species.

All of the above demonstrations of effective enrichment were based on significant decreases in stereotypic behaviors. It is worth mentioning that levels of non-stereotypic active behaviors were also examined as a positive control. For all five enrichment interventions, frequency of non-stereotypic active behavior increased after exposure to the enrichment across subjects. This supports the notion that the decreases in stereotypic behaviors resulted from the enrichment interventions and not from a general decrease among all active-type behaviors. Overall, the hypotheses made for which personality types were suited or not suited for different enrichment types were notably accurate. This finding supports the overall goal of this study that personality can be used as a tool for evaluating individual environmental enrichment plans for a prosimian species.

Limitations and Modifications

There were some limitations with respect to the data and analysis that may affect the accuracy of the results. First, the sample size for this study was small, which has many disadvantages. For example, power is reduced in small samples, increasing the likelihood of a *Beta* error. Also as a consequence of the small sample size, a regression model could not be properly applied, so a median split design was considered the best option. A median split design has its own limitations. Most notably, when using a median split, the variability within the data is lost. This lack of variability causes a general loss in effect size and power (MacCullum et al, 2002). Despite the loss of variance between individuals, a median-split was considered the best option due to the small sample size.

Another possible limitation of the current study and other studies of personality is the use of the most appropriate dimensions of personality. Originally, animal personality research focused on creating species-specific measures, but this approach resulted in inconsistency within personality terminology. The inconsistency made cross-species comparisons difficult. Currently, one possible solution is to apply human personality measures to animals. Specifically, one trend has been to use the Five Factor Model. However, as demonstrated by Gosling and John (1999), not all species can easily fit into the Five Factors, especially the factor of Conscientiousness. A possible alternative to using the Five Factor Model could be the Interpersonal Circumplex Model (Wiggins, 1982). For this scale, traits are arranged in a circular fashion on a plane marked by two axes: Dominance and Nurturance. Comparisons have been made between the Interpersonal Circumplex and the Five Factor Model because Dominance and Nurturance reflect the factors of Extraversion and Agreeableness, respectively (Sodano & Tracey, 2006). However, the Interpersonal Circle notably differs from the Five Factor Model because it focuses on factors that are involved primarily in interpersonal interactions, whereas the Five Factor Model consists of two interpersonal factors (Extraversion and Agreeableness) and three experiential and motivational factors (Neuroticism, Openness to Experience, and Conscientiousness; Sodano &

Tracey, 2006). Considering that animal personality research cannot involve self-report measures and must rely completely on opinions of humans who have a relationship with the animal, assessing motivational and experiential factors, such as Conscientiousness, may lead to anthropomorphic projections. Perhaps, future animal personality research should shift its focus to more observable characteristics and exclude experiential characteristics.

Conclusions

The ultimate goal of studying personality in non-human animals is to relate personality characteristics to observed behavior. Examining individual differences enables animal caretakers to better understand and predict the behavior of animals (Vazire, 2004). This study investigated the practical benefit of applying personality to animal welfare. The data demonstrated that personality was related to the effectiveness of environmental enrichment type for bushbabies. Zoo administrators could use information about the personalities of animals in their care to design individualized plans for environmental enrichment. Future studies could also investigate whether knowledge of personality types can aid in animal management techniques such as breeding and reintroduction programs. The importance of this area of research was profoundly summarized by King (2007): "Failure to include subjective personality measures as a fundamental component of animal behavior studies would be roughly analogous to studying animal behavior exclusively by automatic data recording while scrupulously excluding direct visual observation" (p. 49).

Appendix A

Bushbaby Personality Measure

NOTE: The factor which each adjective falls under is indicated here, but was not included on the actual measure.

1. Curious (Openness to Experience): Appears to be interested in new situations or objects.

2. Comfortable, complacent (Neuroticism): Self-satisfied, content, appears free from anxiety.

3. Aggressive (Neuroticism): Threatens or causes harm, high frequency of grabbing, biting or hitting other animals and/or humans.

4. Affiliative, companionable (Agreeableness): Agreeable and sociable. Appears to like the company of others. Seeks out social contact with another animal or person.

5. Friendly, gentle (Agreeableness): Friendly, amicable, and congenial toward other animals. Responds to others in an easy, kind, manner.

6. Perseverant (Conscientiousness): Strongly motivated to succeed, especially in spite of opposition or obstacles.

7. Careful, cautious (Conscientiousness): Animal exhibits caution in its actions.

8. Active, Energetic (Extraversion): Moves around a lot in a non-stereotypic manner.

9. Timid (Extraversion): Hesitant, apprehensive, tentative.

10. Not exploratory or inquisitive (Openness to Experience): Does not seek out nor investigate novel situations or objects.

Appendix B
Behavioral Ethogram

Date			
Bushbaby(ies) Observed:			
		1 min	**2...**
Instantaneous			
Active	**Non-stereotypical**		
	Stereotypical		
Non Active	**Resting**		
NOTES			
Indicate the location of the animals in the cage by placing the corresponding # next to their initial			
TALLIES	**SUBJECT**		
Side-to-side shift.			
Body-weaving			
Pacing			
Self Mutilation			
Back & Forth Jumping			
Vocal Stereotypy **Notes**			

Appendix C
IACUC Approval Form

The University of Southern Mississippi

Institutional Animal Care and Use Committee

118 College Drive #5147
Hattiesburg, MS 39406-0001
Tel: 601.266.6820
Fax: 601.266.5509
www.usm.edu/spa/policies/animals

INSTITUTIONAL ANIMAL CARE AND USE COMMITTEE
NOTICE OF COMMITTEE ACTION

The proposal noted below was reviewed and approved by The University of Southern Mississippi Institutional Animal Care and Use Committee (IACUC) in accordance with regulations by the United States Department of Agriculture and the Public Health Service Office of Laboratory Animal Welfare. The project expiration date is noted below. If for some reason the project is not completed by the end of the three year approval period, your protocol must be reactivated (a new protocol must be submitted and approved) before further work involving the use of animals can be done.

Any significant changes (see attached) should be brought to the attention of the committee at the earliest possible time. If you should have any questions, please contact me.

PROTOCOL NUMBER: **07051004**
PROJECT TITLE: **Exploratory Behavior in Young and Aged Bushbabies**
PROPOSED PROJECT DATES: **02/07/07 to 02/07/08**
PROJECT TYPE: **New Project**
PRINCIPAL INVESTIGATOR(S): **Sheree Watson, Ph.D.**
COLLEGE/DIVISION: **College of Education & Psychology**
DEPARTMENT: **Psychology**
FUNDING AGENCY/SPONSOR: **HRSA**
IACUC COMMITTEE ACTION: **Full Committee Review**
PROTOCOL EXPIRATION DATE: **09/30/09**

Robert C. Bateman, Jr., Ph.D.
IACUC Chair

5-10-07
Date

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