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Personality and sociality in captive animals: implications for management

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Contents

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ABSTRACT

Interactions that animals experience can have a significant influence on their health and welfare. These interactions can occur between animals themselves, but also between animals and keepers, and animals and the public. Human and non-human animals come into contact with each other in a variety of settings, and wherever there is contact there is the opportunity for interaction to take place. Interaction with companion animals are well known, but human–animal interaction (HAR) (Hosey, 2008) also occurs in the context of farms (Hemsworth and Gonyou, 1997; Hemsworth, 2003), laboratories (Chang and Hart, 2002), zoos (Kreger and Mench, 1995) and even the wild (e.g. Cassini, 2001). This PhD proposes an articulated monitoring scheme to record animal-human interactions and animal-animal interactions in selected zoos and farms. This was accompanied by a survey of animal personality in several institutions in the UK and Italy for welfare, husbandry, breeding programs and reintroduction purposes. The methodological approach was based on direct monitoring of animal behaviour, videos of keeper-animal interactions and animal personality questionnaires completed by experienced keepers and animal handlers. The goal of this project is to create a network between zoos to explore the aforementioned interactions to produce husbandry protocols and explore personality and behavioural traits in multiple species. We present data regarding African lions, Asiatic lion, Sumatran tigers, Brown bears and sloth bears (ZSL London and Whipsnade zoo) interactions with humans and conspecifics and personality profiles from five different dairy cattle breeds. This data is collected across a broad range of environmental conditions and outlines the monitoring protocols developed to collect this data. The data show the great adaptability of these species to ex situ environments, low or absent negative impact of visitors' presence and the relevance of individual personality in these interactions.

OVERVIEW OF THE THESIS

This thesis is organised into seven chapters. Chapter 1 outlined the background to the research and briefly stated the research aim and presents a critical review of the literature on topics relevant to this research and a synthesis of the zoo animal personality and temperament tests literature concluding with a description of the aim, objectives and hypotheses of the research.

Each following chapter presents research studies carried on different taxa (lions, tigers, bears, cattle) in different institutions (zoos, farms) using a common approach (personality questionnaires) and more specie-specific ones (direct observations, SPI, keeper-animal interactions videos, sociograms).

Chapter 2 presents a personality assessment and feline-keepers relationships in ZSL Whipsnade zoo African lions (*Panthera leo*). Behavioural observations were conducted with the purpose of assessing personality in lions and test new methodologies to achieve that goal. Complementarily to the observations, keeper-animal interactions were recorded and a personality questionnaire was given to the keepers for them to rate 28 personality traits (Chadwick, 2014; Wedl, 2011). Methodologies as sociogram, composite sociality index (CSI) and spread of participation index (SPI) were also used to assess personality traits (Rees, 2015; Stanton 2015).

Chapters 3 reports a two-years study on ZSL London zoo Asiatic lions (*Panthera leo persica*). This small pride experienced enclosure change and an increment in human-lion contact. To monitor this change and individual responses to it, direct observations, SPI, personality questionnaires and sociograms were used.

A similar approach, applied to ZSL London zoo Sumatran tiger streak (*Panthera tigris sumatrae*) is presented in chapter 4. Tigers were monitored in 2014 and 2015 during control nights and social event nights (Zoo late nights, Sunset safari nights) and personality profiles and SPI produced.

Chapter 5 is dedicated to Ursids. ZSL Whipsnade zoo brown bears (*Ursus arctos arctos*) and sloth bears (*Melursus ursinus inornatus*) were monitored, keeper-filled personality questionnaires produced and personality profiles of the bears analyzed using the Five Factor Model (FFM).

Chapter 6 outlines a personality survey (based on a modified version of the keeper questionnaires described above) on five different diary cattle breeds (Holstein, Brown

Swiss, Modenese, Varzese, Rendena) in three different farms. Finally, Chapter 7 presents a discussion of the findings of the research. It provides recommendations for further investigation and for improvements to current animal management practices.

1. BACKGROUND

One of the goals of the modern zoo is to contribute to the conservation of threatened species by participating in captive breeding programmes, designed to maintain both the genetic diversity and the demographic composition of captive populations (Wedekind, 2002; Ballou *et al*., 2010; Asa *et al*., 2011; Rees, 2011; Hosey *et al*., 2013).

The success of captive breeding programmes depends not only on the management of populations or groups, but also on the welfare of individuals. The developing field of animal personality research aims to understand variation among individuals and to assess animal welfare from an individual's perspective (Hill & Broom, 2009; Whitham & Wielebnowski, 2009, 2013; Watters & Powell, 2012). There is evidence that personalities within breeding pairs and social groups can affect reproductive success and social group cohesion (Carlstead, Fraser *et al*., 1999; Carlstead, Mellen *et al*., 1999; Kuhar *et al*., 2006).

This research measures the behaviour, time budget, enclosure usage, keeper-animal interactions and personality of captive mammals housed in different social groups. It uses behavioural observations, spread participation index (SPI), keeper-animal interactions videos, sociograms and keeper questionnaires to quantify captive animals social behaviour and personality. The aim of the research is to investigate different taxa personality profiles to outline possible common elements and to determine the effects individual personality on conspecific and interspecific interactions in order to improve welfare, reproductive success and management practices.

1.1. LITERATURE REVIEW

1.1.1. Human-animal relationship

As Hosey writes in his seminal review (2008): human and non-human animals come into contact with each other in a variety of settings, and wherever there is contact there is the opportunity for interaction to take place.

As mentioned earlier, human–animal relationship (HAR) (Hosey, 2008) occurs with companion animals, in the context of farms (Hemsworth and Gonyou, 1997; Hemsworth, 2003), laboratories (Chang and Hart, 2002), zoos (Kreger and Mench, 1995) and even the wild (Cassini, 2001).

Repeated interactions between the same animals and humans can lead to the development of a longer-term relationship between the two (Hemsworth *et al.*, 1993). Such relationships have been the subject of considerable research in those contexts where they involve domesticated species (Hosey, 2008). There has been much less research on human–animal relationships involving exotic species, although they have been reported in animals as diverse as wolves (Fentress, 1992), black bears (Burghardt, 1992) and rodents (Dewsbury, 1992). Indeed they have been a necessary aspect of some research projects involving animal–human communication in chimpanzees (Boysen, 1992) and an African grey parrot (Pepperberg, 1992).

HARs are likely to develop between exotic animals and their keepers, not only in laboratories but also in zoos (Hosey, 2008). The author points out, however, that the difference between the zoo environment and the laboratory and farm is the daily presence of large numbers of zoo visitors, and that it would be surprising if the quality of animal interactions with zoo visitors were not influenced, and in turn had an influence upon, the relationship that the animals have with their keepers. Thus, in applying the HAR concept to the zoo setting, he suggests that we need to consider human–animal interactions involving familiar (keepers, other zoo personnel, zoo researchers) and also unfamiliar (zoo visitors) humans.

Heini Hediger (1970) wrote that of the various ways in which humans might be perceived by zoo animals, keepers were likely to be seen as conspecifics. This could lead to two possible risks: ‘‘the animal sees the keeper as a rival of the same sex and this leads to aggressive behaviour, or it sees in him a potential mate and this may present a danger to the keeper owing to importunate attempts to mate with him''.

Zoo animals probably see the keepers in a different way from the way they see the public (the latter as an enemy, in Hediger's system). This view could be re-framed in terms of the likelihood that animals in zoos will develop a HAR with their keepers, but may have a different, and probably generalised, relationship with the visiting public (Hosey, 2008).

Mitchell *et al*. (1991) concluded that in golden-bellied mangabeys (*Cercocebus galeritus chrysogaster*) zoo visitors were treated like interlopers, keepers like familiar conspecifics, and observers like familiar neighbours. Other primates also behave differently to different categories of humans. Colobus monkeys (*Colobus guereza*) at Paignton Zoo, for example, show different frequencies of interaction with keepers, zoo staff (anyone wearing a zoo uniform but not involved in day-to-day care of those animals) and zoo visitors (Melfi and Thomas, 2005). Interestingly, the authors found that the interactions with all three categories reduced significantly (interactions with zoo visitors stopped altogether) after positive reinforcement training of the animals to facilitate oral examination.

Mellen (1991), investigating the factors that were associated with reproductive success in small cats, found that, amongst other things, the quality of keeper interactions with the cats was a significant predictor of the cats' reproductive success. In particular, a husbandry style characterised by keepers talking to the cats, and interacting with them, was more likely to be associated with the cats having offspring than a style which did not include such interaction. As a consequence, Mellen (1991) recommended that positive human–animal relationships were desirable for successful reproduction, and that this should start with a socialization process involving, for example, stroking and playing with kittens, the aim being to produce cats with a reduced fear of humans but an enriched environment to facilitate normal behavioural development. In clouded leopards (*Neofelis nebulosa*) faecal corticoid levels were associated negatively with the amount of time primary caretakers spent with the animals, but positively with the number of keepers (Wielebnowski *et al.*, 2002). This was interpreted as indicating that a higher number of keepers probably meant that a predictable, high quality relationship between keeper and cat could not be set up, because individual keepers spent less time with the animals (Hosey, 2008).

In white rhinoceros (*Ceratotherium simum*), animals which keepers had rated highly in terms of ''friendliness to keeper'' had significantly lower mean levels of faecal corticoids (Carlstead and Brown, 2005). Although not directly giving evidence of a HAR in these animals, this is nevertheless consistent with the hypothesis that a positive relationship with the caretaker has beneficial effects on the animal's welfare (Hosey, 2008).

1.1.2 Keeper-animal interactions

Zoo animals are daily in contact with humans and while contact with visitors is usually brief and impersonal, keepers have routinely interactions as part of daily husbandry and spend enough time to be recognisable by them. Enrichment and veterinary training also involves close keeper-animal interactions, reciprocal trust and cooperation and are generally recognised as beneficial for animal welfare.

We would like to explore keeper-animal interactions in different species, with different keepers and in different zoos from tigers and lions to bears.

Daily husbandry varies from zoo to zoo and while enrichment and veterinary training might be optional or occasionally administered, feeding and enclosure cleaning are daily and sometimes regular. Keeper–animal interactions can vary from visual contact to tongs-feeding and even physical contact.

Keeper-big cat dyads may be similar in interaction structure to owner–domestic cat dyads because many keepers regard large felines like tigers, lions and cheetahs as being social companions or at least interact with them in various ways during daily husbandry routines in a owner-domestic cat fashion.

Consequently, we predict that dyadic structure will be contingent on keeper and feline personalities, sex, and age as well as duration of the daily interactions and interaction history of the partners.

Few studies focused on keeper-tigers interactions (Phillips and Peck, 2007), more on lions (Tarakini *et al.*, 2014) while domestic cat-owner interactions have been explored in several studies.

We argue if (and at what extend) knowledge about domestic cat-human interactions and intraspecific behaviour (e.g. urban cat colonies) can be used as a model of larger feline's behaviour (Leyhausen, 1979).

Fig. 1.1- Indi and Heidi (*Panthera leo persica*) trained at ZSL Whipsnade zoo by a keeper (Mr. Graeme Williamson)

1.1.3. Visitors-animal interactions

A number of studies have shown results which are best interpreted as indicating that the presence, and particularly the behaviour, of unfamiliar people (usually zoo visitors) is stressful to zoo animals (Hosey, 2008). Most studies have used behavioural measures, but several have used physiological measures. Davis *et al.* (2005), for example, found that urinary cortisol levels in spider monkeys (*Ateles geoffroyii rufiventris*) at Chester Zoo correlated positively with the number of visitors to the zoo. Similarly, in black rhinoceros higher mean faecal corticoid levels were found in zoos where the animals were kept in enclosures with a greater degree of public exposure (Carlstead and Brown, 2005). Hosey (2000) reviewed the relevant literature on the responses of zoo animals to human audiences, and used the literature to test three hypotheses, namely, that the behavioural changes were a simple social facilitation effect, that they were the consequence of the audiences being stressful to the animals, and that they were the consequence of the audiences being enriching for the animals. The evidence mostly supported the stressful hypothesis, with some support for the hypothesis that audiences could under some circumstances be enriching, and with no support for the facilitation hypothesis. However, inconsistencies were noted in the behavioural responses recorded in different studies, and it was suggested that these might be the result of differences between species, between housing conditions, and in the way different audiences were perceived (Hosey, 2008).

It is also worth pointing out that many of the published studies show an association between the behaviour of the animals and the presence of visitors, but do not necessarily indicate unequivocally the direction of causality. Thus, it is also possible to argue that the animals show elevated activity and agonism for some other reason, and that this greater activity in the cage attracts the audience (Mitchell et al., 1992c). This, for example, was considered by Margulis et al. (2003) to be the best explanation of associations they saw between felid behaviour and visitor presence.

The studies reviewed by Hosey (2000) were overwhelmingly primate studies; while this is still the case with the literature, there are now many more studies available, and they show that the situation is even more complex when non-primate studies are available.

Studies on the behavioural changes of felids associated with the presence of zoo visitors are summarised in Table 1.1 (Hosey, 2008**).** There is consistency in the cats' lack of change in activity levels, with one study showing a decrease (Mallapur and Chelan, 2002) and none showing an increase. If activity is taken to be a suitable measure, then this would seem to imply either that cats are not greatly disturbed by the presence of people, or that if they are they do not manifest it in changes in their activity. Again, stereotypy or pacing does not seem to be much affected by the presence of visitors, with the exception of the jaguar in the study by Sellinger and Ha (2005), which showed an increase in pacing as visitor numbers increased, followed by a decrease in pacing as numbers got higher. In the study by Mallapur and Chelan (2002), the leopards showed less stereotypy when on-exhibit, which the authors attribute to enclosure characteristics rather than visitor presence. In general felids appear to show much less behavioural change when confronted with unfamiliar people than is the case with primates.

Species	**Activity**	**Stereotypy /pacing**	**Visible**	**Rest**	**Alert**
Felis viverrinus	No effect				
Neofelis nebulosi	No effect				
Acinonyx jubatus	No effect				
Panthera uncia	No effect	No effect		Increase	Increase
Panthera pardus	No effect, Decrease	No effect		Increase	
Panthera onca		No effect, Decrease	Decrease		
Panthera leo	No effect				
Panthera tigris	No effect				

Table 1.1. Behavioural changes in felids associated with the presence of zoo visitors (modified from Hosey, 2008)

1.2 Animal personality

Personality psychologists describe personality as "psychological qualities that contribute to an individual's enduring and distinctive patterns of feeling, thinking, and behaving" (Pervin & Crevone, 2010).

Thurstone (1934) found that five broad factors were sufficient to explain the analysed coefficients of 60 personality traits. Since these days the ways of exploring personality have developed and a model that relies on these five big groups has formed (Birgersson *et al.*,2011). Goldberg (1993) suggests that it is reasonable to conclude that all trait adjective analyses in humans will bring out a variant of the five-factor structure (Birgersson *et al.*,2011). Consequently, this method, called the Five-factor model, has become very popular in personality studies in recent years and is regarded as one of the best ways to map personality (Gosling & John, 1999). The model is originally based on human psychology but has been taken into the animal domain as the studies of personality in non-human animals are progressing. The five factors, to which descriptive adjectives connected to personality could be divided into, are Openness to experience, Conscientiousness, Extraversion, Agreeableness and Neuroticism. Examples of traits in the Openness to experience factor are adventurous, imaginative and curious. Conscientiousness can consist of traits that e.g. show planned behaviour or self-discipline. Traits such as energetic and a tendency to seek stimulation belong to the factor Extraversion. Agreeableness is characterised by friendliness and a tendency to be co-operative. Finally, Neuroticism consists of a tendency to experience uncomfortable emotions, such as aggression or anxiety (Birgersson *et al*.,2011).

Animal personality it's a relatively new research field based in a quite old idea. Charles Darwin, in his 1872 publication "The Expression of the Emotions in Man and Animals" considers already the existence of emotions in several animals including cats, dogs and primates (Darwin, 1872).

As noted by Chadwick (2014) there is inconsistency in the literature regarding the terms used when describing animal personality (Réale *et al.*, 2007; Freeman & Gosling, 2010; Coleman, 2012). Many researchers refer to "temperament" (Freeman *et al.*, 2004), others to "behavioural profiling" (Carlstead, Fraser *et al.*, 1999; Carlstead *et al.*, 2000) and still others refer to "individual differences" (Wielebnowski, 1999; Blumstein *et al.*, 2006) or "individual distinctiveness" (Carlstead, Mellen *et al.*, 1999). These differing terms are sometimes used interchangeably in the same paper (e.g. Blumstein *et al.*, 2006).

Historically, distinctions were made in the psychology literature between the terms temperament and personality on the basis of age, with temperament describing behavioural differences in children and personality describing differences in adults (Coleman, 2012; Watters & Powell, 2012). Further distinctions between the terms were made on a genetic basis, with some authors arguing that temperament had a genetic element, whilst personality did not (Coleman, 2012). Additionally, the term personality is considered by some authors to be too anthropomorphic to be used in the animal behaviour literature (Gosling, 2008; Weinstein et al., 2008; Meagher, 2009; Freeman & Gosling, 2010). However, little distinction is now made between the terms temperament and personality (Coleman, 2012), and there is little evidence to support the view that the results of animal personality research are distorted by anthropomorphism (Kwan et al., 2008; Weiss et al., 2012). Thus, despite previous disagreements in the literature, Chadwick (2014) concludes that the use of the term personality now seems to be more generally accepted (Gosling, 2008; Freeman & Gosling, 2010).

Based on these considerations, the term personality is used hereafter, defined as "individual differences in behaviour that are thought to be stable across time and situations" (Freeman & Gosling 2010, p. 654).

The Five-factor model has been modified to be applied on species other than humans :in a study conducted by Highfill & Kuczaj (2007) it was modified by listing adjectives within the factors that cohere more with dolphin behaviours (Birgersson *et al.*,2011).

Research in animal personality has been increasing over the last decade as its importance to health outcomes became more apparent (Gartner & Weiss, 2013). In particular, personality has sometimes been used, in conjunction with other tools, for aspects of captive management, including decreasing stress, increasing positive health outcomes, successful breeding, and infant survival. A few such studies have focused on felids, and have shown that there are possible applications for personality in that taxon (Gartner & Weiss, 2013).

The effect of individual differences on the behaviour and reproduction of zoo animals has long been recognised by zoo biologists, yet only recently has the quantitative assessment of personality been used to investigate some of the challenges faced in zoo animal management (Tetley & O'Hara, 2012). Animal personality studies have been carried out in zoos since 1995.

Tetley and O'Hara's (2012) results reveal that zoo animal personality is most commonly assessed using observer ratings, where people who are familiar with the animals are asked to rate them on various personality traits. The reviewed studies indicate that zoo keepers are able to reliably rate animal personality traits, and these ratings are valid and related to behaviour (Tetley & O'Hara, 2012).

Although the study of nonhuman personality has increased in the last decade, there are still few studies on felid species, and the majority focus on domestic cats. Gartner *et al.* (2014) assessed the structure of personality and its reliability in five felids— domestic cats, clouded leopards, snow leopards, African lions, and previous data on Scottish wildcats—and compared the results. In addition to the benefits of understanding more about this taxon, comparative studies of personality structure have the potential to provide information on evolutionary relationships among closely related species (Gartner *et al.*, 2014). Each of the species observed in this study was found to have three factors of personality. Scottish wildcats' factors were labelled Dominance, Agreeableness, and Self Control; domestic cats' factors were Dominance, Impulsiveness, and Neuroticism; clouded leopards' factors were Dominance/Impulsiveness, Agreeableness/Openness, and Neuroticism; snow leopards' factors were Dominance, Impulsiveness/Openness, and Neuroticism; and African lions' factors were Dominance, Impulsiveness, and Neuroticism. The Neuroticism and Impulsiveness factors were found similar, as were two of the Dominance factors. A taxon-level personality structure also showed three similar factors. Age and sex effects were also taken in account (Gartner *et al.*, 2014).

Gartner and Powell (2012) studied personality in snow leopards (*Uncia uncia*) by examining theitr reactions to six novel objects and comparing them to personality assessments based on a survey completed by zookeepers.

Baker and Pullen (2013) assessed the effects of husbandry regimes on the personality of zoo-housed cheetahs (*Acionyx jubatus*) : 35 individual cheetahs from 7 zoos in the UK and Ireland were rated on 25 trait adjectives and 23 observable behaviours.

Chadwick (2014) in a study of male coalitions in captive cheetahs (*Acionyx jubatus*) also measured personality by analysing questionnaires completed by keepers. Twenty personality traits were quantified using analogue visual scales, based on those used by Wielebnowski (1999). Traits measured using similar scales were 'active', 'aggressive to conspecifics', 'aggressive to familiar people', 'aggressive to unfamiliar people', 'calm', 'curious', 'eccentric', 'excitable', 'friendly to conspecifics', 'friendly to keepers', 'fearful of conspecifics', 'fearful of familiar people', 'fearful of unfamiliar people', 'insecure', 'playful', 'self-assured', 'smart', 'solitary', 'tense' and 'vocal'.

1.3 Aim, objectives and hypotheses of the research

The aim of this PhD project is to evaluate the nature of the human–animal relationship in the case of zoo and farm animals, the role of animal personality in this interaction and to suggest a monitoring model which may have predictive value in helping to interpret the ways in which different animal taxa respond to the people they encounter and how to plan and regulate these encounters.

Differences in personality can be assessed, both in animals and humans, with behavioural codings and/or questionnaires based on the Five-factor model. In psychology, the Big Five personality traits are five broad domains or dimensions of personality that are used to describe human personality. The theory based on the Big Five factors is called the five-factor model (Costa and McCrae, 1992).

In semi-social species (or solitary species kept in groups in zoos) it is also important to reflect on the context of the interactions between individuals. Hence, in the ZSL London and Whipsnade zoo studies we also investigate how the individuals interact within a group. Creating sociograms and calculating the coefficient of association will give additional information to the individual personalities according to the Five-factor model.

For the personality studies we propose a modified version of Chadwick's questionnaire. We identify promising areas of development in zoo animal personality research and suggest applications of personality profiling to zoo tigers and lions' welfare and management. We argue that a validated personality questionnaire and/or behavioural codings are a valuable tool for zoo professionals and advocate the implementation of personality assessment into existing zoo management practices to inform decisions on welfare and captive breeding.

2. PERSONALITY AND SOCIALITY OF CAPTIVE ANIMALS: PERSONALITY ASSESSEMENT AND FELINE–KEEPERS RELATIONSHIP IN LIONS (*PANTHERA LEO)*

2.1. ABSTRACT

Animal personality is a growing research area due to the increasing evidence of the impact that it has on welfare, health and management of animals in captivity. Therefore, understanding, testing and improving existent methodologies, as well as develop new ones, to access animal personality is an important step towards improvement of welfare, health and longevity of captive animals. Lions were chosen for this study because the species is understudied compared to other felidae species in personality matters and because it displays a vast, diverse and well known behaviour repertoire that makes possible the study of personality.

Behavioural observations were conducted in ZSL Whipsnade zoo with the purpose of assessing personality in African lions (*Panthera leo*) and test new methodologies to achieve that goal. Complementarily to the observations, keeper-animal interactions were recorded and a personality questionnaire was given to the keepers for them to rate 28 personality traits. Methodologies as sociogram, composite sociality index (CSI) and spread of participation index (SPI) were also used to assess personality traits. Seven profiles of 11 personality traits were produced based on the observations conducted and the potentialities and limitations of the methodologies used were assessed. More data is needed to achieve conclusions about the extent of the usefulness of keeper-animal interactions to access personality, but a sociogram was successfully used to access personality traits.

2.2. INTRODUCTION

African lions (*Panthera leo*) were chosen for this study as they are the truly social felids and possess a large and well known behaviour repertoire, relevant factors to a personality assessment study. Nonetheless, this species personality has been seldom studied as the researcher's main interest within felidae family is the domestic cat (*Felis catus*) (Stanton, 2015).

The most common used methodology in personality studies is based on behavioural observations (Biegersson, 2011; Freeman & Gosling, 2010; Highfill, 2010; Waters & Powell, 2012). Rating questionnaires have grown in recent years as an equally reliable alternative to behavioural observation (Gartner 2014; White & Bennett, 2014) as it requires less time and expertise in data collection as it relies on experienced opinions (usually keepers). A simultaneous use of the two techniques as a way to increase the robustness of the data collected as also been an option for some researchers (Chadwick, 2014; Weld, 2011). A third technique, based on the observation of keeper animal interactions has been used to study the effect of keepers and animals personality in their interactions in a close contact management style with tigers (Phillips & Peck, 2007).

Other tools, usually used in behavioural studies, may also be useful to access personality traits. Among them a sociogram as described by Rees (2015) and applied by Cinková and Bicik (2013) in rhinos and by Chadwick (2014) in cheetahs to study the relationships within a group, the composite sociality index (CSI) used by Michelleta (2012) and by Pullen (2009) to access the quality of relationship between macaques and gorillas, respectively, and the spread of participation index (SPI) developed by Dickens (1955) and adapted by Plowman (2003) to allow the calculation on the index in enclosure zones with different areas.

This study hypothesizes that behavioural study tools, as sociogram, CSI and SPI can be used as a complement to traditional techniques of personality assessment as a way to validate some personality traits. Therefore, the aim of this study is to characterize Whipsnade Zoo's African lions personality, using a combination of the two most common methodologies for the effect, behavioural observations and personality traits questionnaires, using as validation tools, three tests not, so far, used to that purpose. It is also an aim of this study to access the viability of observations of keeper-animal interaction as a complementary method of personality assessment.

2.3. MATERIAL AND METHODS

Behavioural observations

Observations of a captive African lion (*Panthera leo*) pride occurred in ZSL Whipsnade Zoo, Whipsnade, Bedfordshire (51°32'07.1"N 0°09'12.1"W), between May and July 2015. The pride consisted in 7 adult lions; 3 females, 4 males, with ages ranging from 8 to 15 years old (table 2.1). The applied methodology consisted in focal observation sessions of 50 minutes, 7 minutes per animal (Martin & Betenson, 2007). Sessions were realized 4 times a day, between 10:00-10:50, 11:00-11:50, 14:00-14:50 and 15:30-16:20. Times were chosen to get the remnants of morning activity peak since it was not possible to observe during dusk or dawn, due to accessibility limitations. A total of 50 hours of data was gathered on the pride, totalling slightly above 7 hours per animal. The sessions were partially recorded/photographed using a Vivitar DVR 508NHD digital video camera.

Animal	**Age**	**Sex**	**Relationship**	**Reproductive status**
Spike	*14*	M		Vasectomised
Saturn	*15*	F	Full siblings	Implant
Kachanga	*15*	F	Full siblings	Implant
Kia	*8*	F	Full siblings	Implant
Max	*8*	M	Full siblings	Castrated
Toto	*8*	M	Full siblings	Castrated
Neo	*8*	M	Full siblings	Castrated

Table 2.1 – ZSL Whipsnade zoo's African lion pride. Spike and Saturn parented Kia, Max, Toto and Neo while Spike and Kachanga never produced any offsprings.

Figure 2.1: Whipsnade zoo African lions pride.

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The enclosure was divided in 4 zones, as shown in figure 2.2, and the total enclosure area as well as each zone area, were calculated using Google Maps "Area Calculator Tool" (table 2.2).

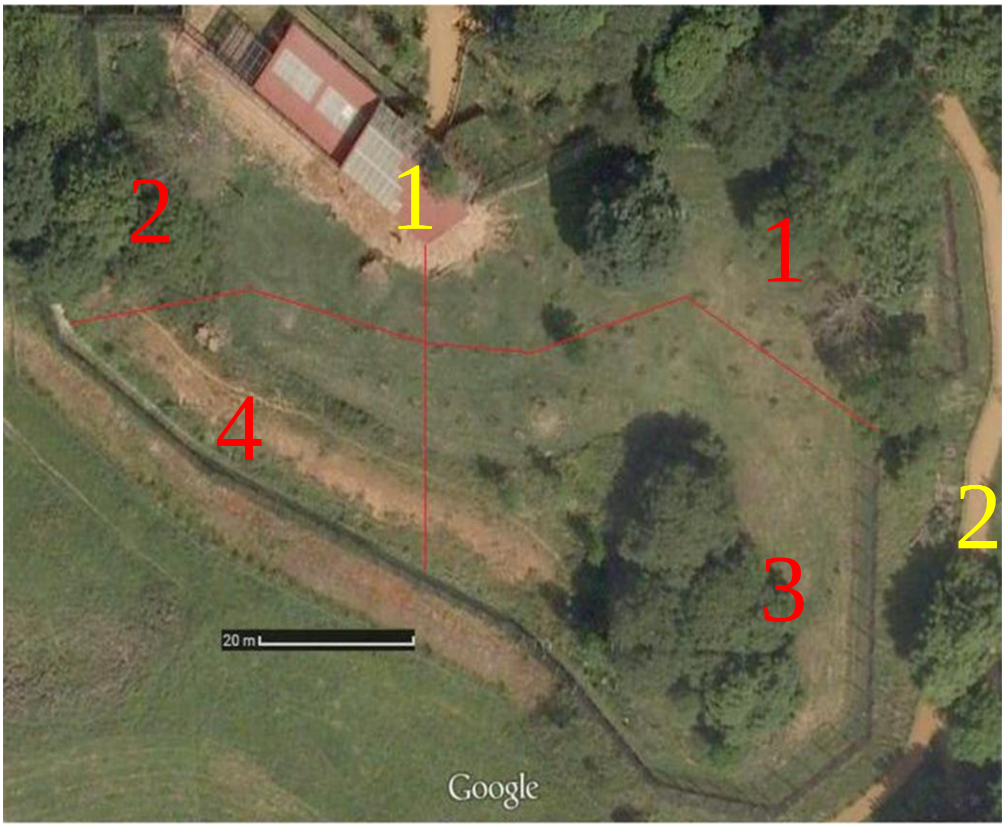


Figure 2.2: Yellow numbers are the observation sites: 1 – observatory; 2 – pathway. Red numbers are the enclosure zones.

Zones	**Features**	**Area (m^2)/ % of total**
1	Hill - High ground, Shade, Enrichment	1409,11/23,3
2	Hill - High ground, Shade, Artificial shelter	1285,59/21,3
3	Shade	2499,75/41,4
4	Tranquillity, Low exposure to visitors	842,54/14
Total		**6036.99/100**

Table 2.2 – Enclosure zones, areas and features

The ethogram used in this study (table 2.3) was built using field studies with wild lions as references (Rudnai, 1973; Schaller, 1973) and then adapted to the format recently proposed by Stanton *et al.* (2015), who developed a standardized ethogram for felids based on the analysis of 95 published behavioural studies covering 30 species of the *felidae* family.

Behaviour	State/Event	Description
Allogroom	Event	Licks the fur of a conspecific
Allogroomed	Event	Has the fur licked by a conspecific
Being mounted	Event	Is mounted by other lion
Bite	Event	Mouth closes on object or conspecific
Chase	Event	Runs after conspecific or other being/object
Chased	Event	Pursued by conspecific
Climb down	Event	Descends an object or structure
Climb up	Event	Ascends an object or structure
Decubitus – Dorsal	State	Lays down on the dorsum
Decubitus – Lateral	State	Lays down laterally
Decubitus - Sternal	State	Lays down on the sternum
Defecate	Event	Relieves colon, releases faeces
Drink	Event	Lapps up water and swallows
Ears backwards	State	Ears oriented backward
Ears forward	State	Ears oriented forward
Eat	Event	Ingests food by chewing and swallowing
Facing conspecific	State	Stares at another animal of the same species
Facing observer	State	Stares at the observer
Facing public	State	Stares at the public
Flehmen	Event	Sniffs, then lift head with open mouth, breath in, eyes almost closed
Head butt	Event	Briefly pushes/bumps its head against a conspecific's head
Lick object	Event	Protrudes tongue from the mouth and strokes object with it
Mount	Event	Moves on top of conspecific in the attempt of copulate
Pace	Event	Repetitive locomotion in a fixed pattern.
Play	Event	Interacts with conspecifics/objects in a non-harmful manner (chasing, manipulating object, jumping, wrestling, etc.)
Proximity to conspecific – near	State	Within one body length of other animal
Rub - Body	Event	Rubs body on conspecific or object
Rub - Head	Event	Rubs head on conspecific or object
Rubbed	Event	Rubbed by a conspecific
Self-groom	Event	Licks own fur
Sitting	State	Upright position, all four feet on ground, front legs straight, back legs folded
Sniff	Event	Smells by inhaling air through the nose
Standing	State	Stands with all four legs extended, paws on the ground, immobile
Spray	Event	Stands with tail raised vertically and releases a jet of urine backwards against a vertical surface or object.
Stalk	Event	Usually slow, forward locomotion with back and head slightly lowered and eyes focused on the stalked individual/object.
Stare	Event	Looks fixedly to something/someone
Tail up	Event	Tail is held vertically, in a upright position

Urinate	Event	Releases urine, standing or squatting
Vocalization	Event	Produces sounds or calls with is mouth/throat
Vocalization – Grunt/Cough	Event	Short, throaty call, characterized by the deep contraction and expansion of the diaphragm
Vocalization – Roar	Event	Long, throaty, high intensity call
Walk	Event	Forward locomotion at a slow gait
Yawn	Event	The mouth is opened widely, the head tips back, lips are pulled back so that the teeth are exposed
Sniff anogenital	Event	Smells the anogenital region of conspecific

Table 2.3 – Ethogram of Whipsnade Zoo, African lion pride. Adapted, in alphabetical order, from Stanton *et al.* (2015)

For the elaboration of the activity budgets, state and event behaviours were grouped as follows:

- **Inactive** - stationing, laying down and not interacting with conspecifics or performing any kind of observable behaviour besides staring;
- **Locomotion** - walking, stalking, climbing and chasing behaviours;
- **Stereotypic** - pacing;
- **Reproductive** - mounting, being mounted and sniffing anogenital region;
- **Maintenance** - defecating, self-grooming and urinating;
- **Marking** – spraying;
- **Vocalizations** – grunting, coughing and roaring;
- **Feeding** – Eating and drinking;
- **Exploratory** – flehmening, licking object, playing with object and sniffing;
- **Interactions** – Allogrooming, been allogroomed, biting conspecific, chasing, being chased, head bumping, playing with conspecific, rubbing, been rubbed and tail up.

These groups were constituted considering the behaviours displayed by the studied animals and classing systems used by other researches (Rees, 2015; Rudnai, 1973; Schaller, 1973; Stanton *et al.*, 2015).

Sociogram and Composite Sociality Index (CSI)

The sociogram was built as proposed by McGrew (Rees, 2015), considering association by proximity the most relevant factor. Data was gathered for this analysis by summing the total amount of minutes spent in proximity in every dyad within the pride, calculating then the Association Index (I) through the following formula:

$$I_{AE} = 2N/n_A+n_E$$

Being A and E two animals within the pride, N, the number of times A and E were seen together (including in a group with others), n_A, the total number of times A was seen and n_E, the total number of times E was seen. The sociogram was drawn with UCINET software (Borgatti, 2002).

Micheletta and Waller's method (Michelleta, 2012) was used to assess quality of relationship considering proximity and grooming as key factors for the CSI, as follows:

$$CSI = [(G_{ij}/G) + (S_{ij}/S)]/2$$

Being G_{ij} the frequency of grooming given and received by numbers of dyad ij, G, the average frequency of grooming for all dyads in the group, S_{ij}, the frequency of sitting within one body length (without grooming) for members of the dyad ij and S, the average frequency of sitting within one body length (without grooming) for all dyads in the group.

Profiling and Personality traits

This study used two independent methods to access animal personality:

1 – Coding behaviours resultant from focal observations;

2 – Coding behaviours from the observation of keeper – animal interactions.

The combined use of these techniques provides a better understanding of the problematic on hand as they cover the approach, namely "bottom up" approach, that has a starting point from measurable data collected in the field. The behaviours observed were coded as for an activity budget. However, the classing procedure had the concern and purpose of creating classes that could be compared (Uher, 2008).

A profile with 11 traits was produced by that methodology:

- **Active** - which includes whenever an animal is moving or, if stationary, is interacting with it's conspecifics or performing some kind of observable behaviour besides staring;
- **Aggressive to conspecifics** – includes bare teeth, paw hitting and bite conspecific;
- **Aggressive to familiar people** – includes bare teeth and growl at familiar people;

- **Curious** – fleheming, lick object, play with object and sniff behaviours;
- **Eccentric** – includes pacing;
- **Friendly to conspecifics** – Allogroom, head bump, play with conspecific, rub and tail up behaviours;
- **Fearful of conspecifics** – Retreats from a conspecific with ears turn backwards and low tail;
- **Fearful of familiar people** – Moves backwards, baring teeth at the proximity of familiar people;
- **Playful** – Chase, play with object and play with conspecific;
- **Solitary** – Time spent more than a body length away from it's conspecifics.
- **Vocal** – Includes vocalizations.

Keeper – animal interactions, during training, were also observed, registered and coded, as to access specific personality traits related to the sociability with humans, as the triad fearful-aggressive-affiliative. The training sessions captured for this study were tongs feeding sessions, where the animal was initially asked to come closer to the keeper, and then asked to crouch or stand up, receiving an edible reward and positively reinforced with a clicker, for the pretended behaviour and asked again or ignored otherwise (Coleman, 2005). In order to not interfere, Keeper – animal interactions were recorded by the keepers themselves, using a Vivitar DVR 508NHD digital video camera and a Vivitar VIV-VPT-1252 Camera Tripod.

Enclosure usage and Spread Participation Index (SPI)

Each animal enclosure usage was determined by processing data gathered during focal observations. SPI was then calculated following Plowman's adaptation (Plowman, 2003) of the methodology originally developed by Dickens (Dickens, 1955), which allows the division of the enclosure in zones with different areas. Therefore, SPI was calculated as follows:

$$SPI = (\Sigma |f_o - f_e|)/2(N - f_{e\ min})$$

Being f_o the observed frequency of a given animal in a zone, f_e, the expected frequency of a given animal in a zone, assuming that the whole enclosure is used evenly with only zone size as a variable, $\Sigma |f_o - f_e|$, the absolute difference between $f_o - f_e$, summed for all zones, $f_{e\ min}$, as the expected frequency of a given animal in the smallest zone, and N, the total number of observations of a given animal in all zones.

Statistical analysis

For statistical analyses, Kruskal-Wallis and Bonferroni test were used and a p value of < 0.05 was considered statistically significant. Both tests as well as data ranking, was performed using the Minitab 16 Statistical Software, by Minitab Inc.

2.4. RESULTS

Enclosure usage and SPI

Enclosure usage is displayed, per animal, in Figure 2.3.

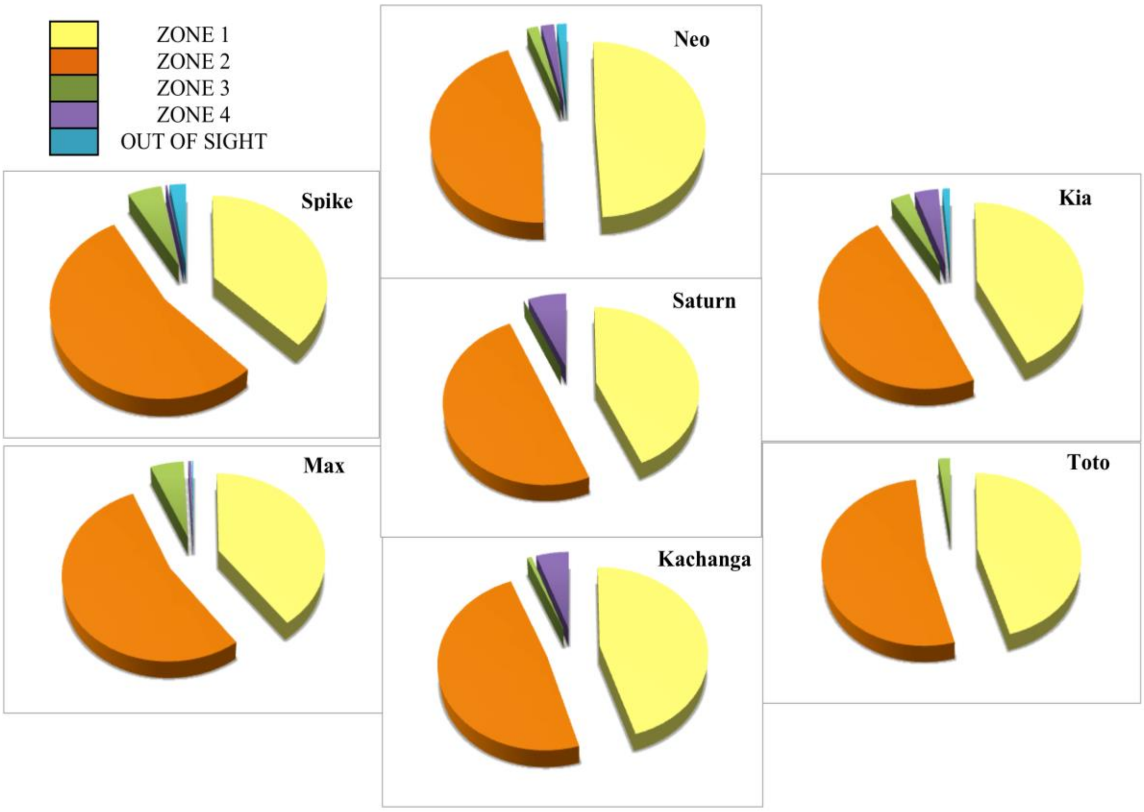


Figure 2.3, from top left to bottom: Spike, Max, Neo, Saturn, Kachanga, Kia and Toto's enclosure usage.
The values are expressed as percentage.

SPI values are displayed in table 2.4, along with the expected and the observed enclosure use.

SPI values range from 0 to 1, meaning 0 an even use and 1 a completely uneven use of the enclosure.

Animal	Zone	Expected use (f_o)	Observed use (f_e)	SPI
Spike	1	23,3%	37,82%	0,56
	2	21,3%	54,06%	
	3	41,4%	5,33%	
	4	14,0%	0,25%	
Neo	1	23,3%	49,35%	0,59
	2	21,3%	45,19%	
	3	41,4%	1,82%	
	4	14,0%	2,08%	
Toto	1	23,3%	45,61%	0,62
	2	21,3%	52,38%	
	3	41,4%	2,01%	
	4	14,0%	0%	
Max	1	23,3%	39,95%	0,56
	2	21,3%	53,75%	
	3	41,4%	5,57%	
	4	14,0%	0,48%	
Kia	1	23,3%	43,10%	0,55
	2	21,3%	48,52%	
	3	41,4%	3,20%	
	4	14,0%	3,94%	
Kachanga	1	23,3%	45,32%	0,57
	2	21,3%	48,61%	
	3	41,4%	0,76%	
	4	14,0%	5,32%	
Saturn	1	23,3%	43,56%	0,56
	2	21,3%	49,88%	
	3	41,4%	0%	
	4	14,0%	6,56%	

Table 2.4 – SPI, expected and real use of the enclosure, per animal.

Sociogram and CSI

Figure 2.4 shows the sociogram of the pride. In a sociogram, the line that connects two animals is accompanied by a number that can range from 0 to 1, representing the closeness of relationship between the two: 1 means inseparable animals, while 0 represent animals that don't cross their paths at all.

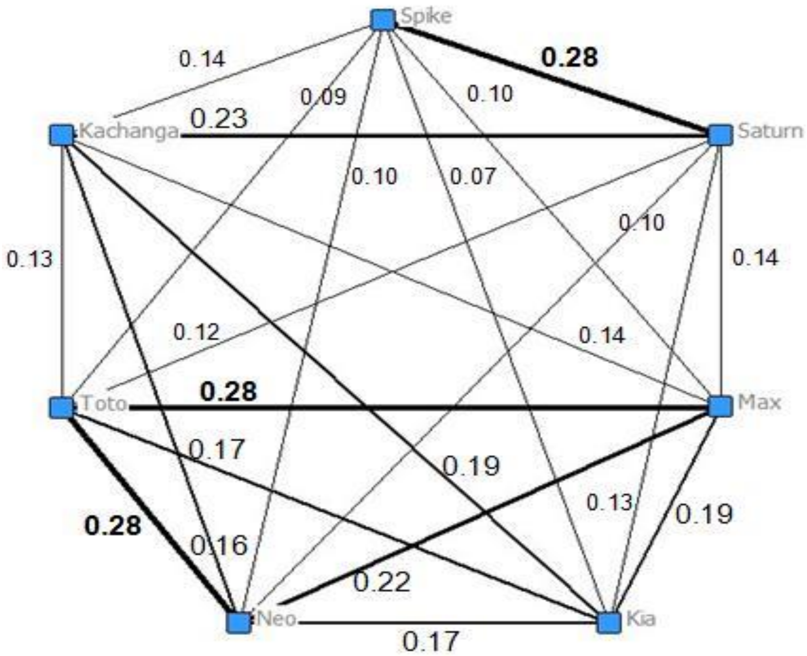


Figure 2.4 – Whipsnade Zoo African lion pride's sociogram

Table 2.5 presents the CSI per dyad. CSI compare the closeness of relationship of a dyad with the average of all the dyads, so closely related dyads will display values above 1 and, in the same way, less related dyads will display values under 1.

Dyad	CSI	Dyad	CSI
Kachanga – Kia	0,73	Saturn – Max	0,46
Kachanga – Max	0,66	Saturn – Toto	0,77
Kachanga – Toto	0,43	Saturn – Neo	0,91
Kachanga – Neo	0,52	Saturn – Spike	1,08
Kachanga – Spike	0,73	Max – Toto	1,98
Kia – Max	0,81	Max – Neo	2,35
Kia – Toto	0,55	Max – Spike	0,48
Kia – Neo	1,11	Neo – Spike	0,47
Kia – Spike	1,14	Toto – Neo	2,76
Saturn – Kachanga	1,64	Toto – Spike	0,25
Saturn – Kia	1,16		

Table 2.5 – Composite sociality index (CSI)

Activity budgets are displayed, per animal, in Figure 2.5.

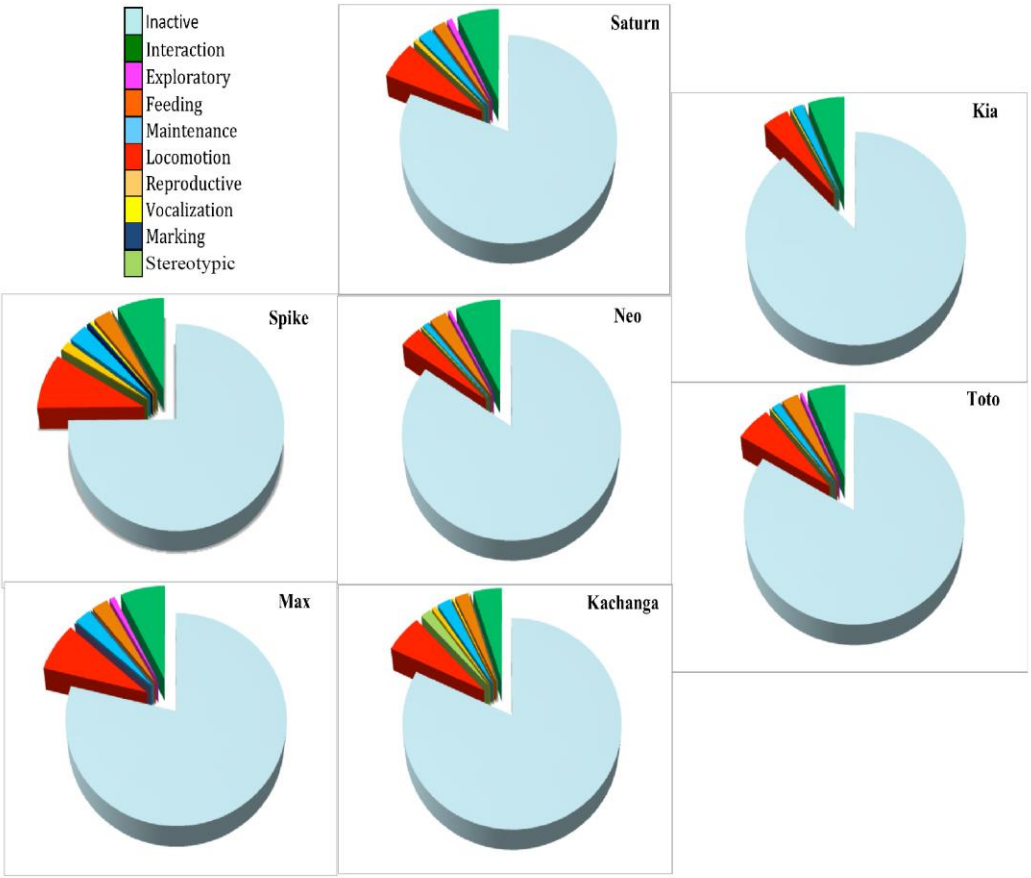


Figure 2.5, from top left to bottom: Spike, Max, Neo, Saturn, Kachanga, Kia and Toto's activity budget.
The values are expressed as percentage.

Proximity to keepers data are displayed, per animal, in Figure 2.6.

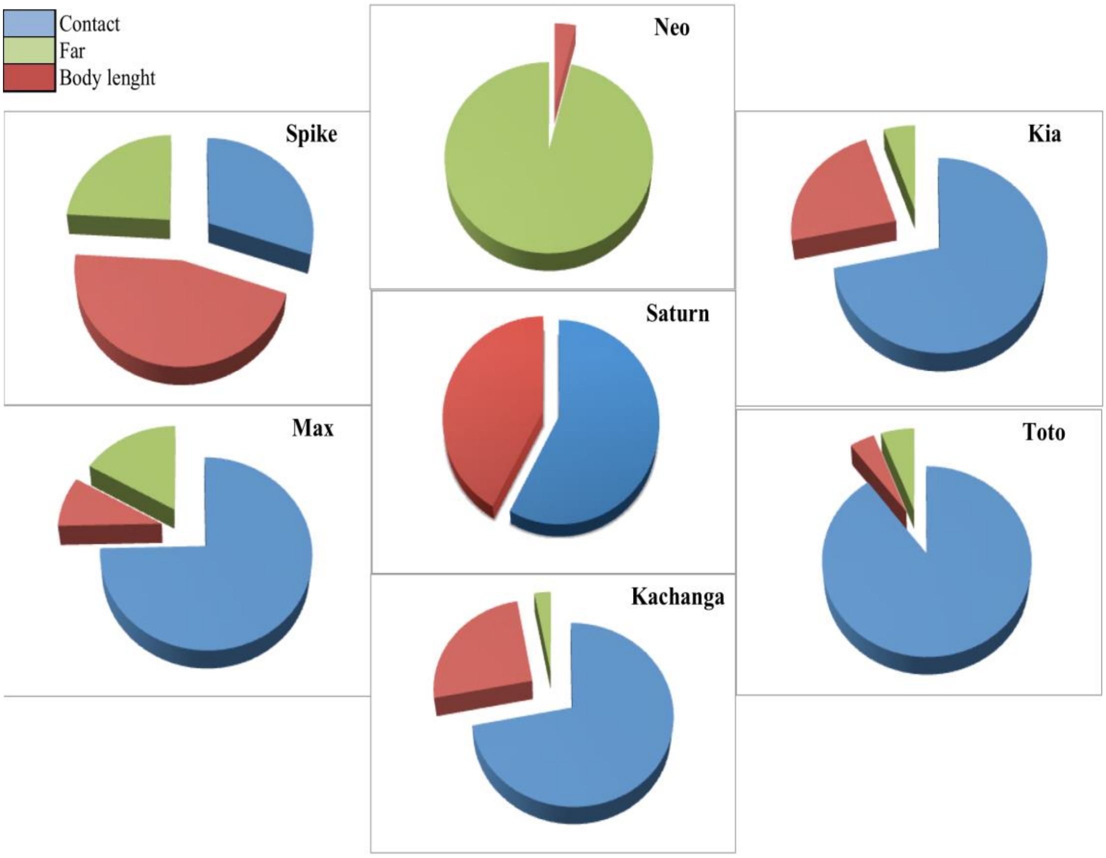


Figure 2.6, from top left to bottom: Spike, Max, Neo, Saturn, Kachanga, Kia and Toto's proximity to keeper.
The values are expressed as percentage.

Personality profiles, per animal, are showed in Figure 2.7.

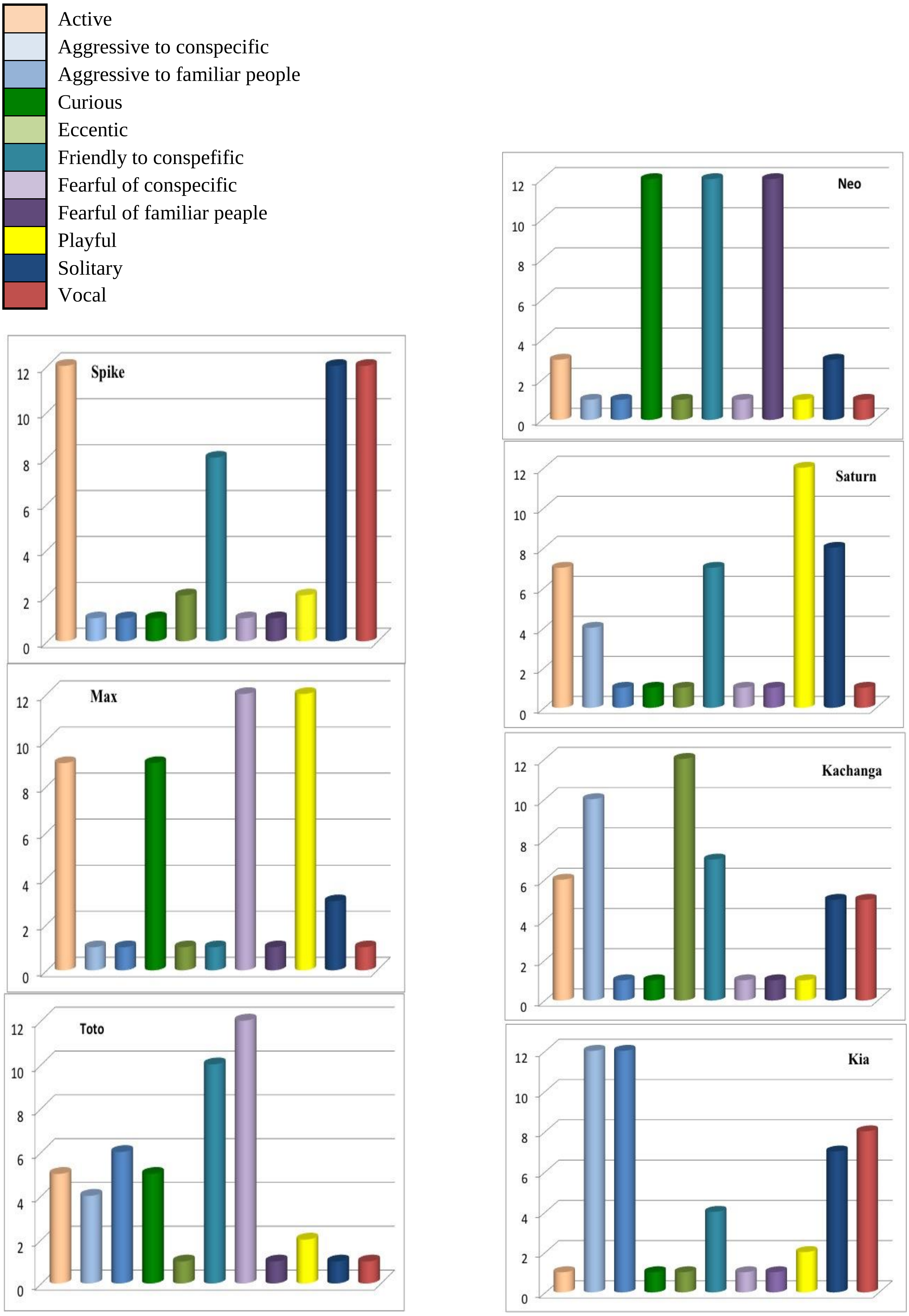


Figure 2.7 personality profiles. Personality profiles were evaluated with a range score between 0 to 12, where 0 was the minimum and 12 the maximum

Keeper-animal interactions, per animal, are displayed in Figure 2.8

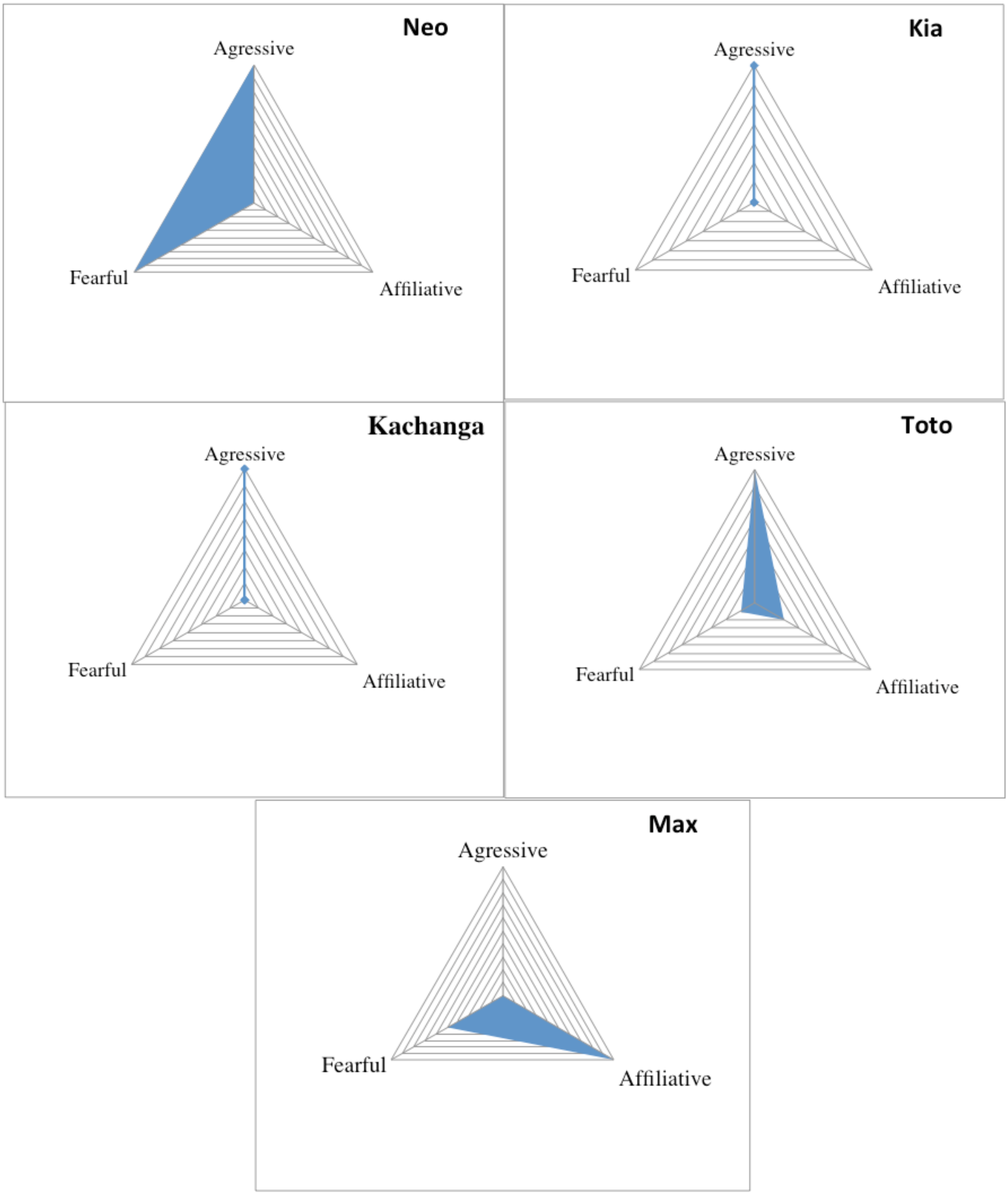


Figure 2.8, from top left to bottom right: Neo, Kachanga, Kia, Toto and Max's keeper interactions in terms of number of aggressive, affiliative and fearful behaviours showed during tongs-feeding sessions with the keeper

Compliance to call during training sessions is displayed on table 2.6.

Animal	**Nº calls answered**	**Total nº of calls**	**Compliance (%)**
Spike	*7*	10	70
Neo	*0*	3	0
Toto	*15*	20	75
Max	*13*	15	86.67
Kia	*14*	18	77.78
Kachanga	*19*	24	79.17
Saturn	***7***	**8**	**87.5**

2.5. DISCUSSION

Enclosure usage and SPI

Enclosure usage observations revealed, in all animals, a consistent preference, for two of the four zones at their disposal (zones 1 and 2), resulting in a non-at-all even usage of the enclosure, as the SPI results confirm.. This preference can be due to several factors, such as the presence of shelters from the elements, provided by an artificial structure near the observatory, the availability of a source of water, the proximity to the building where the animals are managed and from where keepers arrive, the presence of high ground platforms, with good visibility all around, as well as feeding and enrichment delivery points. Interesting, both zone 1 and zone 2 are the more exposed to the visitors presence.

Three animals, Spike, Kia and Neo, exhibit a more distributed usage of the enclosure, despite the observations realized suggest different drivers for that behaviour, connected with different personality traits. Spike displays significant amount of time exhibiting patrolling behaviour, sometimes during an entire day, exploring the full extent of the enclosure, stopping sometimes to sniff, vocalize (consistently, grunts) and stare at objects/animals/visitors outside the enclosure. This is reflected in Spike's time budgets, where inactive is lower and locomotion is higher compared to the rest of the pride.

Kia, in her turn, is an animal that is often seen away from the group, which inevitably leads to a bigger dispersion within the enclosure.

Neo's results are different from his peers, firstly because he uses all four zones of the enclosure, and secondary for being the only animal in the pride, which prefers zone 1 to zone 2. Neo showed, during keeper-animal interactions, fear of the keepers, staying as distant from the keeper as physically possible. Neo was the only animal to display such behaviour.

Although the data collected is insufficient to draw conclusions, this information suggests that Neo's preference of zone 1, where contact with public is less proximal, might be related with his avoidance of proximity with keeper during tongs feeding.

Sociogram and CSI

The sociogram reveals which animals are more sociable, within the pride, and also the preferential social partners of each animal. As suggested in other studies (Rudnai, 1973; Schaller, 1973), although mating occurs between the dominant male and several females of a pride, the relationship between those dyads is not exactly comparable. Spike, the dominant male, shows clear preference for Saturn, who is mother of Kia, Neo, Toto and Max, over Kachanga or Kia. This is also confirmed by the observation of the number of copulations attempted and consummated by Spike with the different females.

Also expected was the close relationship by same gender kin, with a clear proximity between Toto and Neo, Toto and Max and, even to a slightly less extent, Max and Neo and Saturn and Kachanga. Overall, summing the strength of all dyads, per animal, Max and Toto come up as the most sociable animals in the pride while Spike is the least sociable one.

The CSI results suggest stronger affiliation between Toto and Neo, Max and Neo and Max and Toto, which doesn't diverge much from the sociogram results. However, other values were not as concordant: Spike and Saturn dyad displayed a slight above average result (1,08), less than Kia and Spike (1,14) who had scored the lowest value in the sociogram. These discrepancies may be explained by the social value of grooming being different in felids and primates, for whom this test was developed. Although, as in primates, grooming in felids has a purely affiliative side, being a sign of trust and relational proximity between two animals, it also has a hierarchical side, in which low status animals tend to groom high ranking animals as way to please their elders (Joslin, 1973). This difference may explain why animals that don't score highly on a proximity based index, as the sociogram, may score higher in a proximity and grooming based index as CSI. Observations also suggest that Kia may be a low status animal within the pride as she is the least preferred mating option for Spike.

Keeper-animal interactions

The data collected through keeper-animal interaction observations was quite limited both quantitatively and qualitatively, due to the low number of videos that was possible to record during the duration of this study. However, the data collected, indicates not only that useful data for personality assessment can be gathered using this methodology, but also that different animals show different behaviours in training situations. Building up data and understanding about keeper-animal interactions is a valuable asset for any association that manages animals, as keeper-animal relationships have been co-related with animal welfare (Weld, 2011).

Toto, Kia and Kachanga displayed aggressive behaviours (growls and bare teeth), mostly in reaction to initial approximation of the keeper and as a reaction to a sudden or unexpected movement. Kia also seems to display these behaviours as a way to capture the attention of the keeper (e.g.: trying to get food). However, all the 3 animals displayed quite high compliance rates (equal or above 75%), which suggest familiarity with the training method as well as trust on the keeper with whom they are interacting.
Spike and Saturn did not display any aggressive, affiliative or fearful behaviour during tongs feeding (for this reason they are not represented in figure 2.8).

The only animal, which has no compliance, was Neo, who would not even approach the keepers, keeping himself as far as possible, on top of wooden platforms that provide him high ground safety. No aggression, pacing or any kind of stereotypic behaviour was observed in this animal, which just did not approach, not complying with the calls.

Anticipatory behaviours in the form of pacing were briefly observed in Toto, Max and Kia and more often in Spike and Kachanga, despite their high compliance rates and absence of aggressive or in any other way unusual behaviour.

Activity budgets and personality profiles

Activity budgets show a consistency of behaviour within the pride with some minor, although noteworthy, differences between individuals. Spike has the most frequent reproductive activity within the group, followed, in frequency, by Saturn and Kachanga, while the castrated males seldom show any reproductive behaviour at all, as well as Kia. It was not found in consulted references any explanation why Kia should be unfavoured in reproductive terms. Nonetheless, the abnormal stability of social dynamics in captivity may have an influence in the establishment and maintenance of long term reproductive and relational preference with individuals that, in the wild, would probably be overthrown of their position, due to old age. Other possibilities considered include Kia’s aggressiveness to conspecifics and her small stature.

Some individual differences were also spotted in activity rates, with Spike standing out as the most active animal in the pride, and Kachanga displaying more stereotypic behaviours. Marking behaviour, as expected, was displayed only by Spike. Some slight individual differences were evidenced in the time spent interacting with conspecifics. Interactions, however, show a considerable individual difference when they are analysed qualitatively instead of quantitatively, with some animals, as Kia or Kachanga, displaying more aggressive behaviours, as bite or paw hitting, while others, as Neo or Max, performing head rub or groom, both affiliative, as more common interactions. Time spent during maintenance or feeding behaviours showed only slight quantitative differences between animals.

The profiles show unequivocally individual differences in the 11 used traits. These traits are a result of both focal observation and keeper – animal interaction observation and provide a valuable insight into the way each of these animals behaves. The eccentric trait reveals in which animals, finding enrichment solutions to reduce anxiety levels related to anticipatory behaviours and pacing in general, should be prioritized. Although not of major concerning this pride, Kachanga spend an appreciable part of her time pacing. Spike only displayed this behaviour, according to the observations, when in proximity of keepers, which suggests anticipatory behaviour related to feeding time.

In the long term, if they subsist, traits like aggressive to or fearful of familiar people will support the need of developing new managing/training techniques and methods for this specific animals, that can then be applied in the future if other animals display the same traits. Neo was the only animal that did not comply with the calls of the keepers during tong feeding sessions, ignoring the calls and moving to high ground in the furthest wall from the keepers. Although, no signs of aggression or stereotypic behaviour were recorded from that animal. Understanding how to mitigate the shyness or reluctance to approach humans will be a useful step in the welfare and health management of the pride. As previously mentioned, this study only had access to data from few training sessions in a relatively short time frame, undoubtedly not enough to make a fair and accurate assessment of this traits and their implication in the animals social relationships and their management.

Playful and curious traits can be used to predict how to mitigate or prevent stereotypic behaviours or promote natural behaviours (e.g.: a curious animal will have more interest in a novel object and a playful animal will spend more time playing with interactive objects that provide sensorial stimuli). Neo had a high score in curious but not in playful, revealing that it does approach novel/enrichment objects in an exploratory way, but it does not linger interacting with the object. Max, on the other hand, had a high score on both, showing the boldness to approach and the desire to manipulate and play with the object. Saturn had a low score in curious but high in playful, suggesting that she responds quite well to enrichment but does not approach easily novel objects. These observations confirm data about Snow leopard (*Uncia uncia*) reaction to novel object tests from Gartner and Powell (2012). According to these authors male snow leopards visited the novel objects significantly more times than females and, within sex, older females spent more time in contact with the objects.

Friendly, aggressive and fearful of conspecifics, as well as, solitary, may indicate how an animal fare while being transferred, managed (as the area is smaller), or just being in the same enclosure as other conspecifics, providing a useful tool to consider these matters. Kia and Kachanga had high scores on aggressive, Neo and Toto on friendly, Toto and Max on fearful and Spike on solitary. This information may be useful to group lions to manage purposes, as knowing their traits, makes managers able to avoid a fearful – aggressive combination, especially if there was any previous case of aggression between specific animals.

2.6. CONCLUSION, LIMITATIONS AND FUTURE WORK

The results obtained show a methodology to successfully characterize personality in captive Lions. Keeper – animal interactions prove to be a promising source of data for some social personality traits, despite the low quantity of data accessed during this study compromised somewhat the information output obtained from that methodology. Analytic tools like the sociogram and the spread participation index prove of useful to access personality traits both related with social aspects within the pride and the way the animal uses the enclosure. Composite sociality index provided mixed results probably due to the less straightforward meaning of grooming in felids comparing to primates for whom this methodology was initially developed. Overall, a significant progress was made to develop an approach that can reliably access animal personality and impact their health and welfare through more customized management, which can better suit different individual needs.

Improvements can be made in these methodologies increasing the hours of observation, namely, through the installation of time lapse cameras that would allow gathering data from animal behaviour 24 hours per day, seven days a week, with special relevance to dusk and dawn, when this species is more active, would also prove invaluable, not only by increasing the quantity of behaviours accessed but also by increasing the diversity of the same, improving the ability of successfully identify and characterize personality traits in the studied animals.

3. ROLE OF PERSONALITY IN BEHAVIORAL RESPONSES TO NEW ENVIRONMENTS IN CAPTIVE ASIATIC LIONS (*PANTHERA LEO PERSICA*)

3.1 ABSTRACT

Studying personality in captive animals may enable the development of more individual-based management decisions in terms of husbandry, enrichment, and breeding, which may help to improve overall animal welfare. The Asiatic lions (*Panthera leo persica*) at London Zoo represent an opportunity to research an understudied species' response to new environments. In the last few years, these lions have experienced several social and physical changes, such as new enclosures and increased social interaction with humans. This project aimed to investigate the role of personality in behavioral responses to these new environments. Lion personality questionnaires completed by keepers and direct focal animal observations were used to create personality profiles. Time budgets and enclosure use were determined and compared between control nights and human social event nights, and between the lions' previous enclosure and their new one. The results showed a lack of a difference in time budget and enclosure use between control nights and social event nights, and overall the Spread of Participation Index values revealed the lions use their enclosures unevenly. Personality profiles identified various traits (e.g., curious and eccentric) that could assist with individual-based management decisions, such as enrichment strategies. As the first study to assess Asiatic lions personality, this research contributes to the creation of consistent and valid methodology for evaluating captive animal personality. Personality assessment may help to improve husbandry and welfare protocols for individual lions, leading to the improved health and success of the species.

3.2 INTRODUCTION

The Asiatic lions (*Panthera leo persica*) at London Zoo have experienced new social and physical environments throughout the last few years. The three females (Rubi, Heidi, and Indi) have moved twice in two years during the construction of their new enclosure at London Zoo, Land of the Lions. A male lion, Bahnu, moved to London Zoo in March 2016. The lions experienced increased human interaction with the opening of the Gir Lion Lodges next to their enclosure and the onset of Sunset Safari evening social events at the zoo during June and July. Other research has documented captive animals' individual responses to new environments (Carlstead *et al.*, 1999; Hill and Broom, 2009). The results of a literature search indicate this is the first study to evaluate Asiatic lion personality. Few studies have been published on felid personality, and most focus on domestic cats (Baker and Pullen, 2013; Chadwick, 2014; Gartner and Weiss, 2013).

The Asiatic lion is a lion subspecies that resides in Gujarat, India, and is listed as Endangered by IUCN (Breitenmoser *et al.*, 2008). Although once near extinction, the wild population has been growing steadily due to increased conservation efforts. As of 2015, the Asiatic Lion Census estimated the wild population to be approximately 523 individuals (DeshGujarat, 2015). Considering the small wild population, captive Asiatic lion research provides valuable insight into the species' biology and behavior. Captive breeding programs, such as the international ones that London Zoo participates to with other zoos, allow for maximization of the species' genetic diversity and, should the need arise, provide individuals for supplementation of wild populations (Ballou *et al.*, 2010).

The social and physical changes experienced by the lions guided the development of this study, which aims to evaluate the role of lion personality in their behavioral responses to new environments. This study hypothesizes that personality traits identified from keeper questionnaires and observation data create reliable profiles that associate with individual lion behavioral responses to new physical and social environments. Therefore, because of individual personality variation, this study also hypothesizes that these new environments will alter individual time budgets and enclosure use. To test these hypotheses, previously collected behavioral data (i.e., time budget and enclosure use) from Whipsnade Zoo were compared with data from their new enclosure at London Zoo. These data were also compared between control nights and Sunset Safaris. Considering this behavioral data, personality profiles were constructed to determine if certain traits are associated with individual lion responses to new environments. A sociogram was constructed to determine if the relationships between the lions are impacted by their individual personalities.

This study can be considered a case study that may be used to improve the management of these four individuals. Furthermore, this research has wider implications for management of the species, in terms of husbandry, enclosure design, health, welfare, and breeding program success. As of December 2015, there were approximately 359 Asiatic lions in captivity (Srivastav, 2016, pers. comm.). Therefore, a study on four animals can provide essential captive lion behavior and personality data, which can be applied in other collections around the world.

3.3 METHODS

Study Area and Subjects

The Asiatic lion pride at London Zoo consists of three females and one male (Table 3.1). The study took place at Land of the Lions, the recently expanded lion enclosure at London Zoo. The females moved into Land of the Lions in February, 2016, from their temporary enclosure at Whipsnade Zoo, and Bhanu arrived in March, 2016, from Winnipeg, Canada. Except for a few brief introductions, the females and Bhanu were kept in separate areas of the enclosure.

Table 3.1: Members of the Asiatic lion pride at London Zoo.

Name	***Age***	***Sex***	***Relationship***
Rubi	7	F	Full siblings
Heidi	5	F	Full siblings
Indi	5	F	Full siblings
Bhanu	6	M	Unrelated

Fig. 3.1. From top left: Heidi, Indi and Rubi, London Zoo Asiatic lions pride.

Observation Data

Data collection took place from May 31-July 19, 2016. Focal animal behavioral observations using continuous sampling were completed to record the state and event behaviors at one minute intervals for each animal (Martin and Bateson, 2007). Observations were separated into three categories: daytime, control night, and Sunset Safari. Sunset Safaris occurred on Friday evenings from 6 to 10 pm, during which visitors could enjoy food, drink, and performances while exploring the zoo. Daytime observations took place between 8 am and 5 pm on Tuesdays and Fridays, followed by the respective control night and Sunset Safari observations from 6 to 9 pm.

Each 60 minute observation period was divided such that 15 minutes were spent observing each animal. An observation session ended if the focal animal spent five consecutive minutes out of the observer's sight (e.g., indoor). Total observation time summed between observation periods was approximately 87 hours. Included in each observation period were recordings of weather (i.e., sunny, cloudy, or rainy), temperature (Weather.com, 2016), approximate crowd size, and decibel readings at five minute intervals. Individual lion identification was facilitated by assistance from keepers during the pilot study and by use of binoculars to note specific markings on each individual.

The behaviors recorded followed a standardized felid ethogram compiled by Stanton *et al.* (2015), which was adapted for this project based on behaviors observed during a pilot study and on an ethogram constructed by Joslin (1973). To create time budgets, similar behaviors were put into classes (Table 2), based on groups in similar research (Soares and Quintavalle Pastorino, 2015; Stanton *et al.*, 2015). Times when the lions were out of the observer's sight were not included in the time budgets because they did not have access to their indoor area during most observation sessions, so being out of sight was not a possibility. A full ethogram is provided in Appendix 1.

Table 3.2. Behavioral classes used to create time budgets. Individual behaviors come from the full ethogram, included in Appendix 1.

Class	***Behaviors Included***
Inactive	Lie, sit, stand, stretch, stare
Locomotion	Walk, run, stalk, chase, climb, crouch
Stereotypic	Pace
Reproductive	Mount, sniff anogenital region, lordosis
Maintenance	Defecate, urinate, self-groom, scratch
Marking	Spray, scratch object
Vocalizations	Growl, grunt, roar, cough
Feeding	Eat, drink
Exploratory	Any interaction with objects, sniff, flehmen, dig
Interactions	Allogroom conspecific, bite conspecific, play with conspecific, chase conspecific, stalk conspecific, swat conspecific, head/body rub conspecific, tail up, band on glass

The London Zoo enclosure was divided into 27 zones to distinguish areas that may be used for different purposes. Twenty-one zones were located in the females' section of the enclosure and six in the male's section. The Whipsnade Zoo enclosure consisted of eight zones. These zones were assigned so that an animal's specific location could be recorded during each observation, which was used to determine each lion's enclosure use for each observation period. Maps of the London and Whipsnade Zoo enclosures and zone descriptions are available in Appendix 2.

The spread of participation index (SPI) was calculated to determine evenness of enclosure use. Originally created by Dickens (1955), SPI was further developed by Plowman (2003) to allow for zones of unequal areas. Enclosure blueprints provided the areas of Land of the Lions (2195 m^2) and the enclosure at Whipsnade Zoo (230 m^2). Possible SPI values range from 0 (even use of the enclosure) to 1 (uneven use of the enclosure). The calculation for SPI is:

$$SPI = \frac{\sum|f_o - f_e|}{2(N - f_{e\,min})}$$

Where,

f_o = the observed frequency of an animal in a zone.

f_e = the expected frequency of an animal in a zone.

$\sum|f_o - f_e|$ = the sum of the absolute value of the difference between f_o and f_e for all zones.

$f_{e\,min}$ = the expected frequency of an animal in the smallest zone.

N = the total number of observations of an animal in all zones.

London Zoo time budgets and enclosure use were compared to Whipsnade Zoo data, which was collected using the same methodologies in 2015. The data were also compared between Sunset Safaris and control nights. A sociogram was constructed showing the strength of relationships between individuals using time spent in proximity of another lion (i.e., at body-length or nearer). This was completed by calculating Association index (AI) values for each relationship, as used by Schaller (1972) and described by Rees (2015). Possible AI values range from 0 (never seen in proximity) to 1 (always seen in proximity).

$$Association\ index = \frac{2N}{n_1 + n_2}$$

Where,

N = the number of times lions 1 and 2 were seen together (including when around the third lion).

n_1 = the total number of times lion 1 was seen (whether alone or with other lions).

n_2 = the total number of times lion 2 was seen (whether alone or with other lions).

Personality

Personality profiles were compiled using questionnaires completed by seven London and Whipsnade Zoo keepers in 2015. The methodology for these questionnaires was adapted from Chadwick's research on cheetah personality (2014). Questionnaires listed 22 traits, which were rated on a scale of 1 (trait was never exhibited) to 12 (trait was always exhibited) by the keepers for each lion. Recent research using these questionnaires led to more traits being added to Chadwick's questionnaire, such as "Friendly to unfamiliar people" (Soares and Quintavalle Pastorino, 2015). A full questionnaire is provided in Appendix 3.

Behaviors recorded during observations were coded similar to time budgets such that classes could be compared to some of the traits on the personality questionnaire (Table 3). Behavioral classes follow those used in similar studies (Baker and Pullen, 2013; Chadwick, 2014; Wielebnowski, 1999). Profiles created from questionnaires were compared with profiles compiled from observation data. Not all traits were comparable between profiles because only behaviors representing some traits were observed during this study.

Table 3.3. Personality trait classes consisting of behaviors from full ethogram, included in Appendix 1.

Class	***Behaviors Included***
Active	When an animal is exhibiting any observable behavior other than staring
Aggressive to Conspecific	Bite conspecific, swat conspecific
Curious	Play with object, pounce on object, stalk object, swat object, bite object, dig, sniff, flehmen
Eccentric	Pacing
Friendly to Conspecific	Allogroom conspecific, head/body rub conspecific, play with conspecific, tail up
Playful	Chase conspecific, play with conspecific/object, stalk conspecific/object, pounce on conspecific/object
Solitary	Time spent alone (i.e., greater than one body length away from conspecific)

Vocal	Growl, grunt, roar, cough

Statistical Analysis and Data Presentation

Data analysis was completed using Microsoft Excel 2013 and IBM Statistical Package for the Social Sciences. Due to a small sample size, most tests for statistical significance were deemed inappropriate and therefore analysis focuses on descriptive statistics. Inter-rater reliability was calculated for the personality questionnaires using intraclass correlation *ICC* (3,*k*) for the reliability of the mean ratings of the raters (Shrout and Fleiss, 1979).

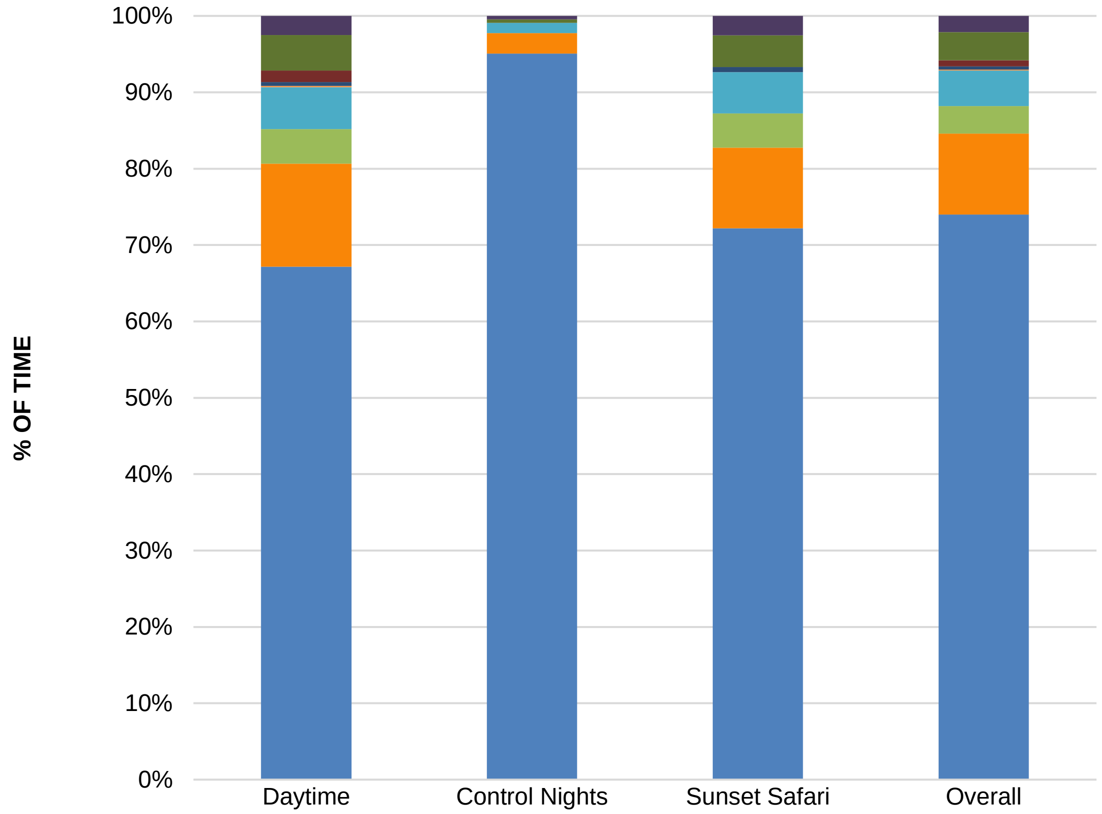
3.4 RESULTS

Bhanu spent little time in his outdoor enclosure during the study because he was still adapting to the enclosure, which totaled to only a few minutes of observation data. Therefore, he was not included in data analysis.

Time Budgets

The females' time budgets were calculated for each observation period. These were also combined to create overall time budgets for each observation period and in total for all observations. The charts, including data values, are displayed below (Figures 3.2-3.4).

Rubi

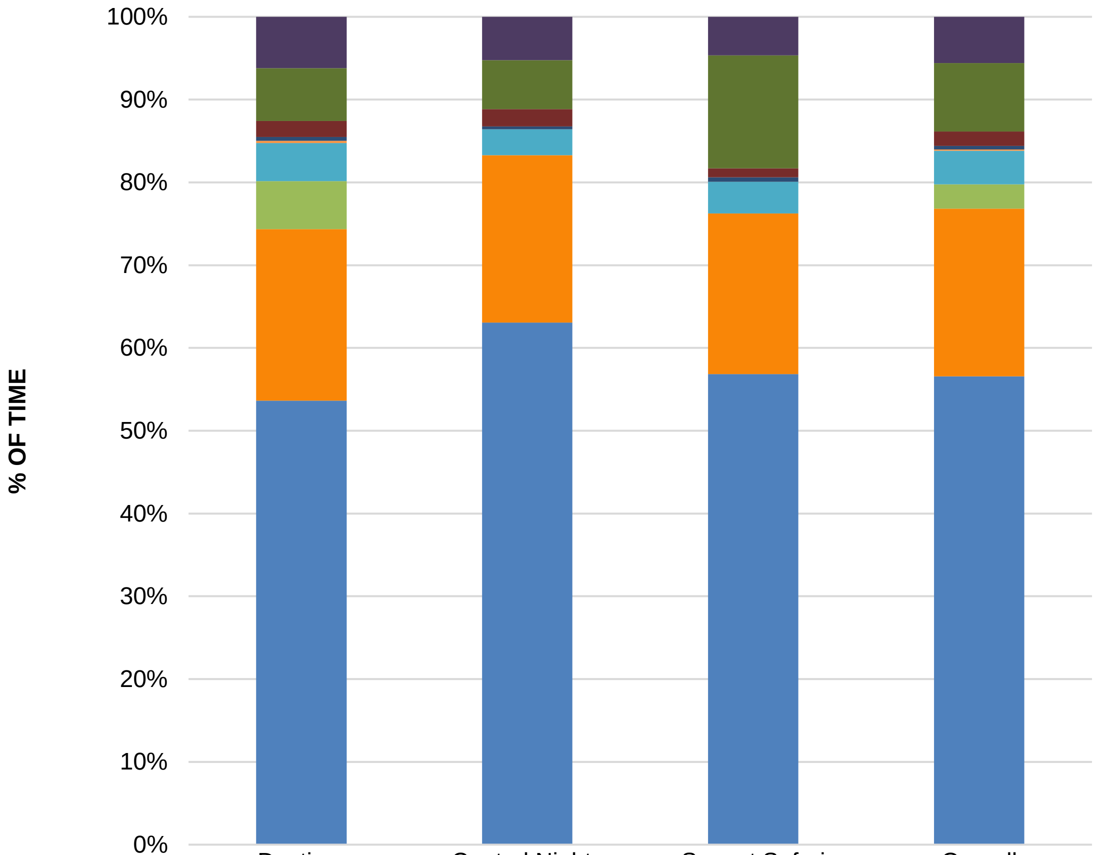


	Daytime	Control Nights	Sunset Safari	Overall
Interactions	2,5%	0,5%	2,6%	2,1%
Exploratory	4,7%	0,5%	4,2%	3,7%
Feeding	1,5%	0,0%	0,0%	0,8%
Vocalizations	0,5%	0,0%	0,6%	0,4%
Marking	0,2%	0,0%	0,0%	0,1%
Maintenance	5,5%	1,4%	5,4%	4,7%
Reproductive	0,0%	0,0%	0,0%	0,0%
Stereotypic	4,5%	0,0%	4,5%	3,6%
Locomotion	13,5%	2,7%	10,5%	10,6%
Inactive	67,2%	95,0%	72,2%	74,0%

OBSERVATION PERIOD

Fig. 3.2. Rubi's time budget for each observation period and overall at London Zoo. Data values are included to show exact percentages of time for each behavior class.

Heidi

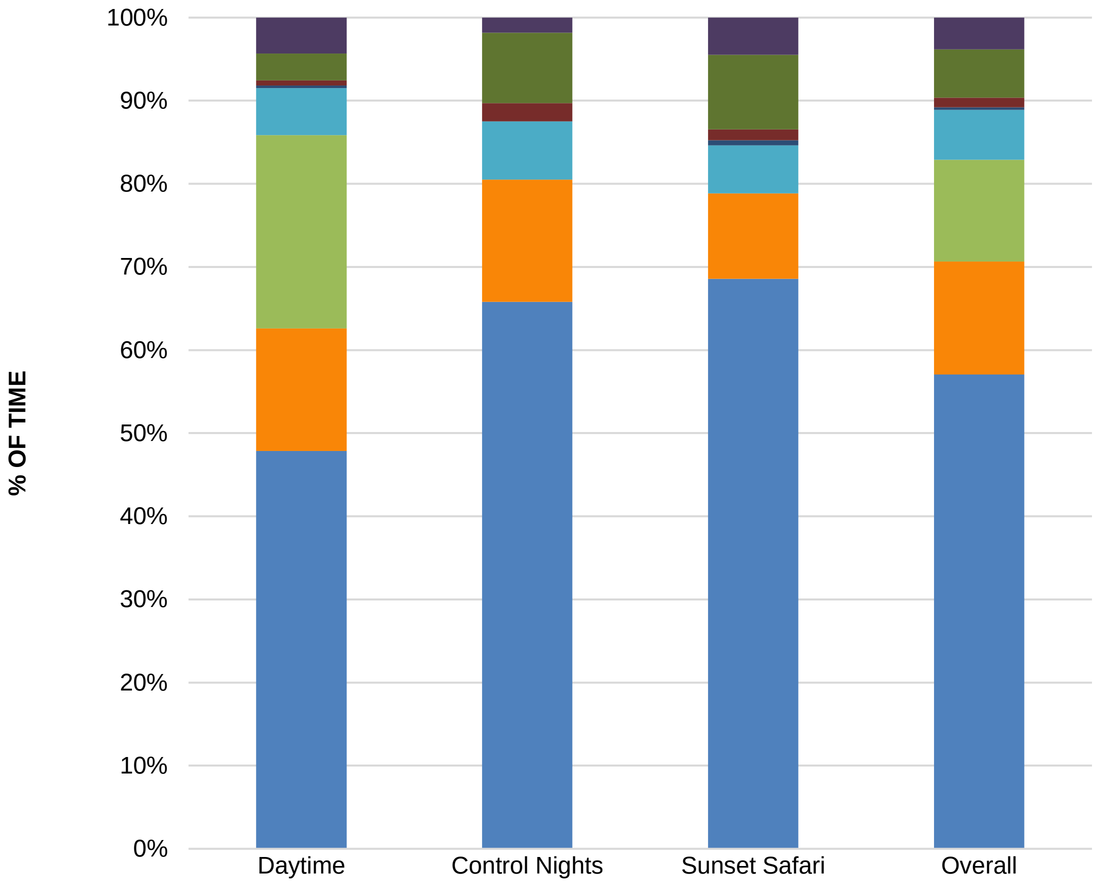


	Daytime	Control Nights	Sunset Safari	Overall
Interactions	6,2%	5,2%	4,6%	5,6%
Exploratory	6,4%	5,9%	13,7%	8,3%
Feeding	1,9%	2,1%	1,1%	1,7%
Vocalizations	0,4%	0,3%	0,5%	0,5%
Marking	0,3%	0,0%	0,0%	0,2%
Maintenance	4,6%	3,1%	3,8%	4,1%
Reproductive	0,0%	0,0%	0,0%	0,0%
Stereotypic	5,8%	0,0%	0,0%	2,9%
Locomotion	20,7%	20,2%	19,4%	20,3%
Inactive	53,6%	63,1%	56,8%	56,6%

OBSERVATION PERIOD

Fig. 3.3. Heidi's time budget for each observation period and overall at London Zoo. Data values are included to show exact percentages of time for each behavior class.

Indi



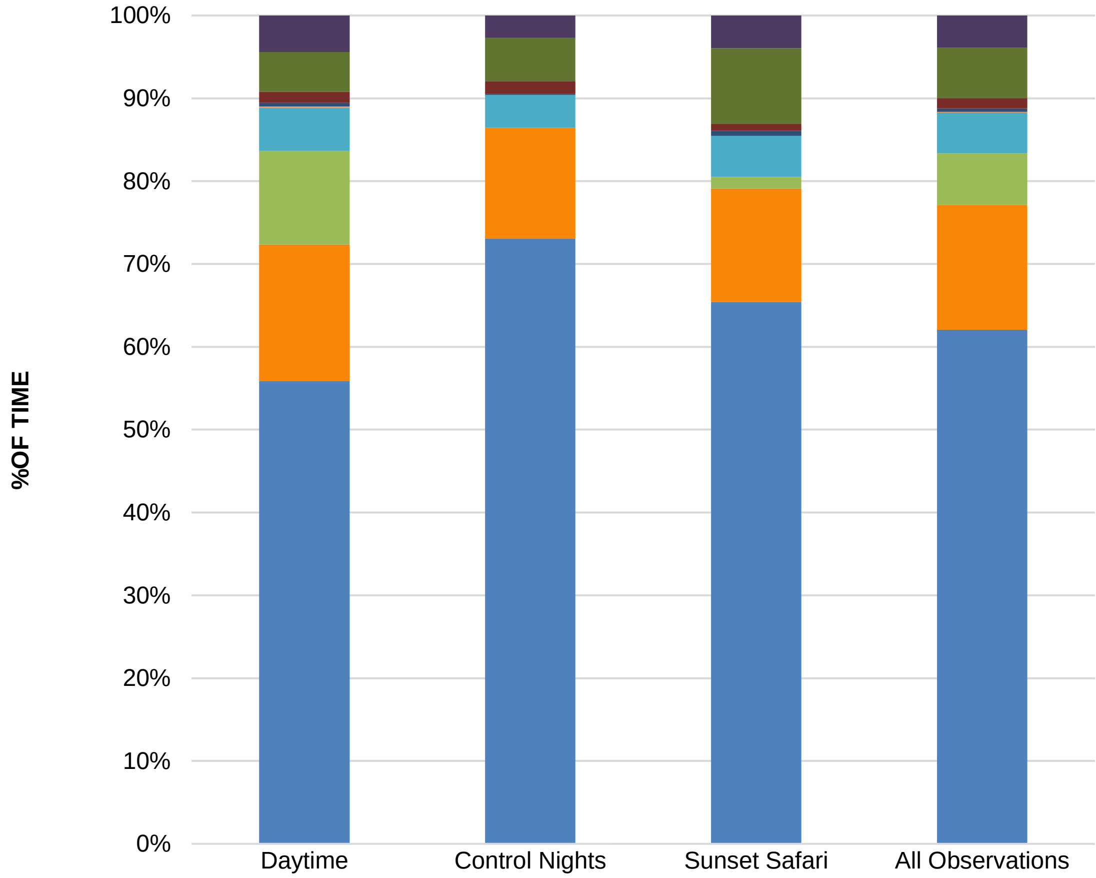
	Daytime	Control Nights	Sunset Safari	Overall
Interactions	4,3%	1,8%	4,5%	3,8%
Exploratory	3,2%	8,5%	9,0%	5,8%
Feeding	0,6%	2,2%	1,3%	1,1%
Vocalizations	0,3%	0,0%	0,6%	0,3%
Marking	0,0%	0,0%	0,0%	0,0%
Maintenance	5,7%	7,0%	5,8%	6,0%
Reproductive	0,0%	0,0%	0,0%	0,0%
Stereotypic	23,2%	0,0%	0,0%	12,2%
Locomotion	14,8%	14,7%	10,3%	13,6%
Inactive	47,8%	65,8%	68,6%	57,1%

OBSERVATION PERIOD

Fig. 3.4. Indi's time budget for each observation period and overall at London Zoo. Data values are included to show exact percentages of time for each behavior class.

Overall

The chart below shows the overall time budget for each observation period (all females combined), and the time budget for all observations (Figure 3.5).



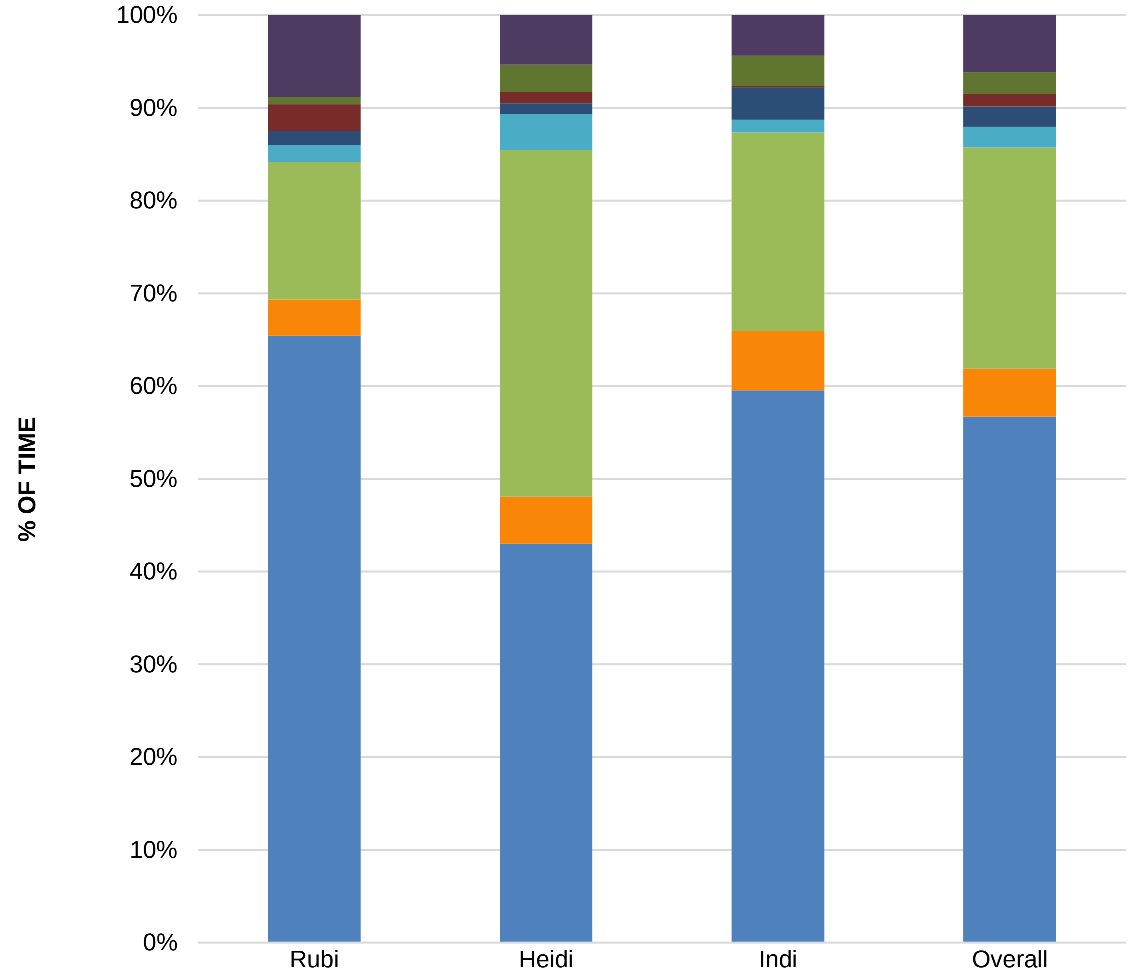
	Daytime	Control Nights	Sunset Safari	All Observations
Interactions	4,4%	2,7%	3,9%	3,9%
Exploratory	4,8%	5,2%	9,2%	6,1%
Feeding	1,4%	1,5%	0,8%	1,2%
Vocalizations	0,4%	0,1%	0,6%	0,4%
Marking	0,2%	0,0%	0,0%	0,1%
Maintenance	5,2%	4,0%	4,9%	4,9%
Reproductive	0,0%	0,0%	0,0%	0,0%
Stereotypic	11,3%	0,0%	1,4%	6,2%
Locomotion	16,5%	13,3%	13,7%	15,1%
Inactive	55,9%	73,1%	65,4%	62,1%

OBSERVATION PERIOD

Fig. 3.5. Overall time budgets for each observation period and a complete time budget for all observations at London Zoo. Data values are included to show exact percentages of time for each behavior class.

Whipsnade Zoo

Displayed below are time budget data for each female while they were at Whipsnade Zoo (Figure 3.6).



	Rubi	Heidi	Indi	Overall
Interactions	8,8%	5,3%	4,4%	6,1%
Exploratory	0,8%	3,0%	3,2%	2,3%
Feeding	2,9%	1,2%	0,2%	1,4%
Vocalizations	1,6%	1,2%	3,4%	2,2%
Marking	0,0%	0,0%	0,0%	0,0%
Maintenance	1,8%	3,9%	1,4%	2,2%
Reproductive	0,0%	0,0%	0,0%	0,0%
Stereotypic	14,8%	37,4%	21,4%	23,9%
Locomotion	3,9%	5,0%	6,4%	5,2%
Inactive	65,5%	43,0%	59,5%	56,7%

Fig. 3.6. Time budgets for each female for Whipsnade Zoo in 2015. Data values are included to show exact percentages of time for each behavior class.

Overall by Observation Period

Enclosure Use

Table 4. Enclosure use values at London Zoo for each female and overall for each observation period, and in total for all observations.

	Daytime				*Control Nights*				*Sunset Safari*				*All Observations*
	Rubi	Heidi	Indi	**Overall**	Rubi	Heidi	Indi	**Overall**	Rubi	Heidi	Indi	**Overall**	
Zone 1	50.5%	46.5%	57.5%	**51.5%**	0.0%	1.3%	2.6%	**1.3%**	6.3%	1.4%	0.8%	**2.9%**	**27.8%**
Zone 2	9.2%	9.8%	23.4%	**14.2%**	6.7%	0.0%	0.0%	**2.2%**	6.6%	0.0%	0.0%	**2.3%**	**8.4%**
Zone 3	0.6%	1.3%	0.7%	**0.9%**	0.0%	0.4%	0.0%	**0.1%**	0.0%	0.0%	0.0%	**0.0%**	**0.5%**
Zone 4	0.2%	6.7%	0.4%	**2.4%**	0.9%	0.4%	1.3%	**0.9%**	1.0%	0.0%	0.0%	**0.4%**	**1.5%**
Zone 5	0.6%	0.4%	0.9%	**0.6%**	0.0%	0.0%	0.0%	**0.0%**	5.2%	0.3%	0.0%	**1.9%**	**0.8%**
Zone 6	1.7%	1.6%	0.0%	**1.1%**	0.0%	2.1%	0.0%	**0.7%**	1.7%	0.7%	0.0%	**0.8%**	**0.9%**
Zone 11	0.0%	0.0%	0.0%	**0.0%**	0.0%	0.0%	0.0%	**0.0%**	0.7%	0.0%	0.0%	**0.2%**	**0.1%**
Zone 12	4.1%	3.8%	2.9%	**3.6%**	13.4%	8.1%	0.4%	**7.2%**	27.3%	0.0%	0.0%	**9.4%**	**5.9%**
Zone 13	14.4%	14.4%	5.6%	**11.4%**	57.6%	51.3%	66.8%	**58.6%**	31.8%	61.6%	72.0%	**54.6%**	**33.0%**
Zone 14	2.2%	0.2%	0.0%	**0.8%**	0.0%	0.0%	0.0%	**0.0%**	0.3%	0.0%	0.0%	**1.9%**	**0.9%**
Zone 15	11.6%	4.4%	7.6%	**7.8%**	0.0%	0.0%	0.0%	**0.0%**	9.1%	5.1%	0.0%	**4.9%**	**5.3%**
Zone 16	0.0%	1.8%	0.0%	**0.6%**	0.0%	0.9%	0.0%	**0.3%**	0.3%	5.1%	0.0%	**1.9%**	**0.9%**
Zone 17	0.0%	0.0%	0.0%	**0.0%**	0.0%	0.0%	0.0%	**0.0%**	0.0%	0.0%	0.0%	**0.0%**	**0.0%**
Zone 18	0.7%	2.2%	0.2%	**1.0%**	0.0%	3.4%	0.4%	**1.3%**	0.3%	3.4%	0.8%	**1.6%**	**1.2%**
Zone 19	1.1%	2.5%	0.0%	**1.2%**	0.0%	1.7%	2.6%	**1.4%**	5.9%	2.1%	2.4%	**3.5%**	**1.9%**
Zone 20	0.4%	0.4%	0.0%	**0.2%**	0.0%	1.3%	0.9%	**0.7%**	0.3%	2.7%	3.1%	**2.0%**	**0.8%**
Zone 21	1.1%	1.8%	0.2%	**1.0%**	0.0%	3.8%	2.2%	**2.0%**	2.4%	5.1%	6.3%	**4.6%**	**2.2%**
Zone 22	0.2%	0.7%	0.0%	**0.3%**	0.0%	0.4%	2.2%	**0.9%**	0.3%	5.1%	0.8%	**2.2%**	**0.9%**
Zone 23	0.0%	0.2%	0.0%	**0.1%**	0.0%	0.0%	0.4%	**0.1%**	0.0%	0.7%	0.4%	**0.4%**	**0.2%**
Zone 24	1.1%	0.2%	0.0%	**0.4%**	0.4%	0.4%	0.4%	**0.4%**	0.0%	1.4%	0.0%	**0.5%**	**0.4%**
Zone 25	0.4%	1.1%	0.7%	**0.7%**	21.0%	24.4%	19.8%	**21.7%**	0.0%	5.1%	7.5%	**4.1%**	**6.2%**

Similar to time budgets, the females' enclosure use was calculated for each observation period and for all observations (Table 3.4). The 21 zones in the females' section of the enclosure are included; Zones 7-10 are located in the indoor dens and were not included in this study.

Due to the number of zones, simplified charts are also shown for each observation period's overall enclosure use (Figure 3.7), which combine zones into two categories: the original part of the enclosure (Zones 1-18) and the new part (Zones 19-25).

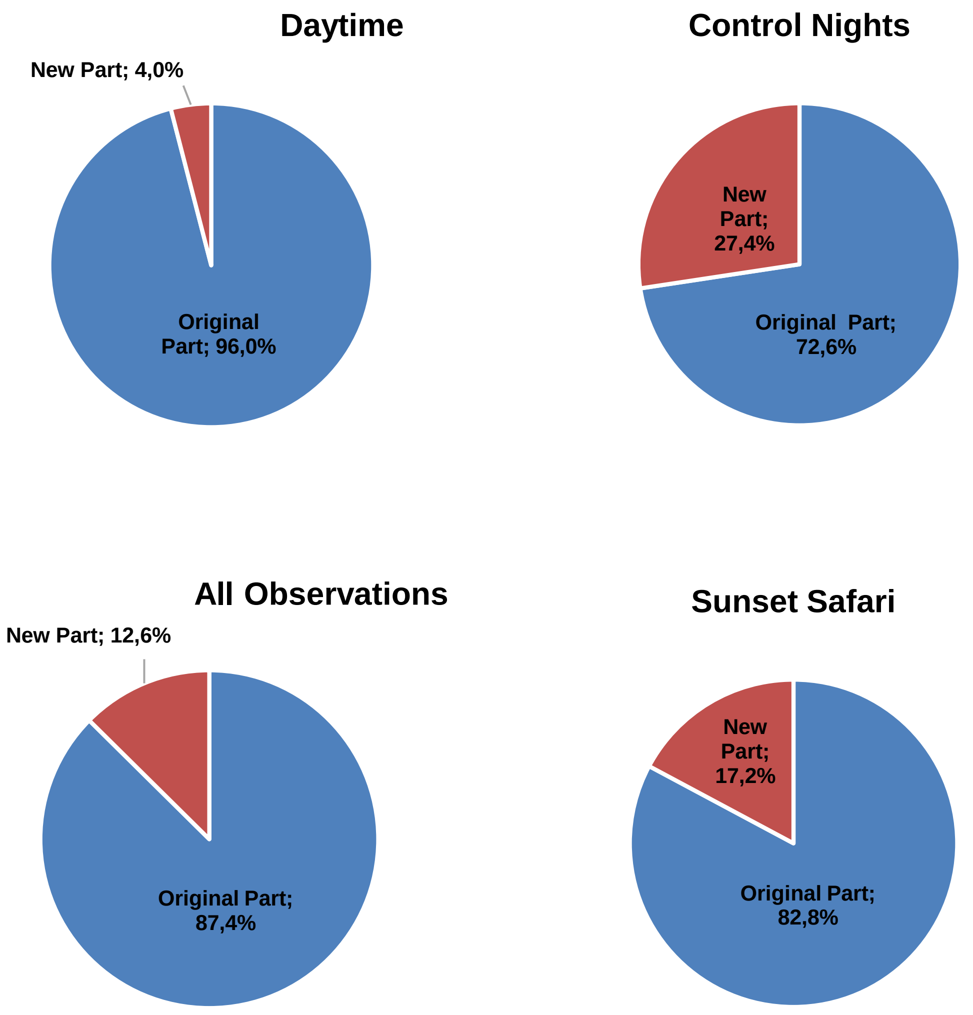


Fig. 3.7. General enclosure use for each observation period and for all observations.

Weekly Comparison

Shown below are the enclosure use values combined for the three females categorized by week of daytime observations to show the change in enclosure use over time (Table 3.5). To make this easier to visualize, also shown for each week's enclosure use are simplified charts that combine zones into the original part of the enclosure and the new part (Figure 3.8).

	Week 1	***Week 2***	***Week 3***	***Weeks 4-5***
Zone 1	82.2%	52.5%	30.2%	54.1%
Zone 2	13.5%	19.2%	15.9%	7.9%
Zone 3	1.2%	0.9%	1.1%	0.4%
Zone 4	0.4%	1.1%	2.2%	5.3%
Zone 5	0.0%	0.4%	0.2%	1.4%
Zone 6	0.0%	0.2%	3.4%	0.4%
Zone 11	0.0%	0.0%	0.0%	0.0%
Zone 12	0.0%	0.0%	0.2%	12.1%
Zone 13	1.5%	21.6%	10.5%	7.7%
Zone 14	0.0%	0.0%	0.4%	2.2%
Zone 15	1.2%	0.2%	27.7%	0.0%
Zone 16	0.0%	0.0%	0.0%	2.0%
Zone 17	0.0%	0.0%	0.0%	0.0%
Zone 18	0.0%	1.5%	1.6%	0.6%
Zone 19	0.0%	0.7%	2.7%	1.2%
Zone 20	0.0%	0.0%	0.7%	0.2%
Zone 21	0.0%	0.9%	0.9%	1.8%
Zone 22	0.0%	0.0%	0.9%	0.2%
Zone 23	0.0%	0.0%	0.0%	0.6%
Zone 24	0.0%	0.2%	0.7%	0.6%
Zone 25	0.0%	0.7%	0.7%	1.2%

Table 3.5. Weekly enclosure use values for London Zoo daytime observations to demonstrate how the females' enclosure use changed throughout the study. Weeks 4 and 5 are combined as there were fewer observation sessions in Week 5.

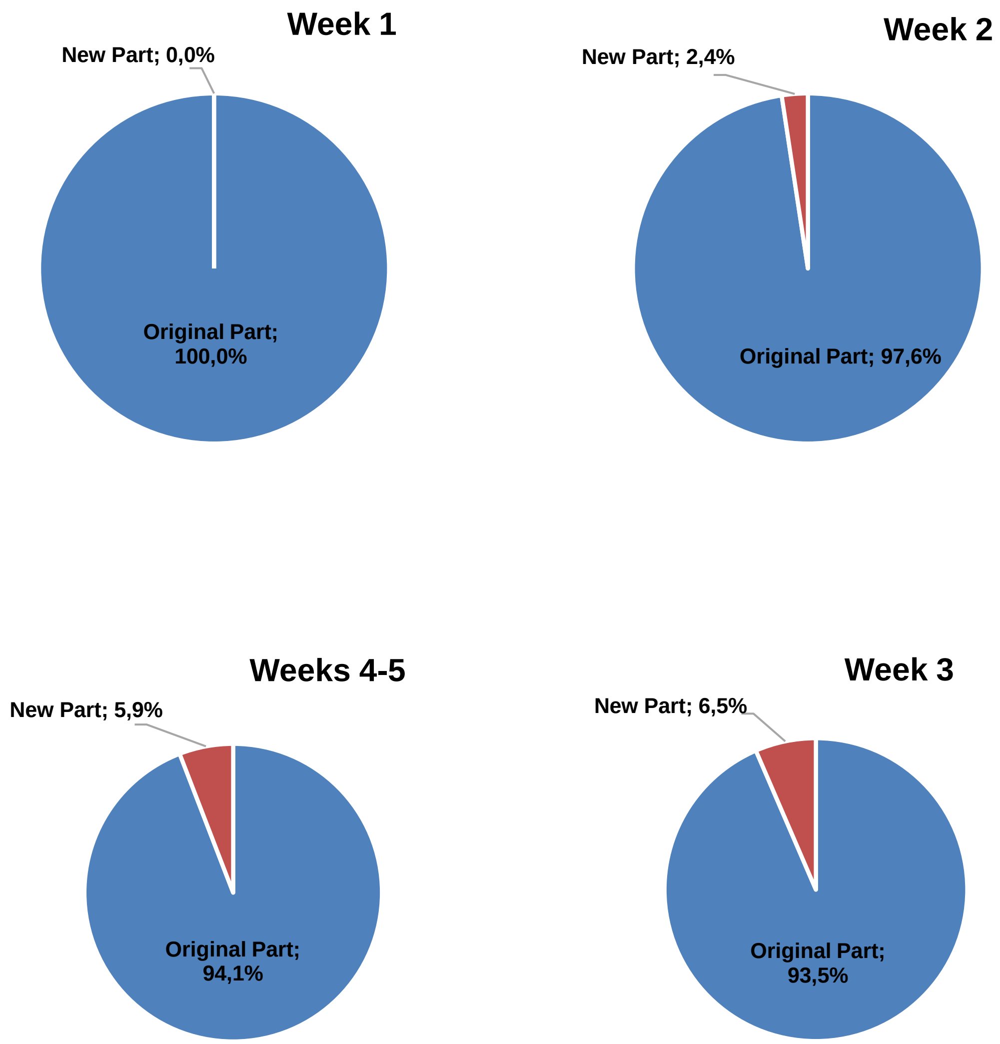


Fig. 3.8. General weekly enclosure use (daytime observations) to compare how the females' enclosure use changed throughout the study.

Whipsnade Zoo

Whipsnade Zoo enclosure use for each female and overall are shown below (Table 3.6).

Table 3.6. Enclosure use values for each female and overall at Whipsnade Zoo in 2015.

	Rubi	***Heidi***	***Indi***	***Overall***
Zone 1	52.7%	76.7%	54.5%	61.5%
Zone 2	2.1%	0.9%	4.2%	2.5%
Zone 3	2.5%	1.9%	1.5%	1.9%
Zone 4	0.0%	0.9%	0.3%	0.4%
Zone 5	38.9%	14.5%	39.0%	30.6%
Zone 6	0.4%	0.0%	0.0%	0.1%
Zone 7	3.5%	5.0%	0.6%	3.0%
Zone 8	0.0%	0.0%	0.0%	0.0%

<u>SPI</u>

SPI values for Whipsnade Zoo and London Zoo are displayed in Table 7 below.

Table 3.7. SPI values for each female for Whipsnade Zoo and London Zoo observations.

	Whipsnade Zoo	***Daytime***	***Control Nights***	***Sunset Safari***	***Overall 2016***
Rubi	0.69	0.78	0.87	0.70	**0.72**
Heidi	0.70	0.69	0.77	0.69	**0.63**
Indi	0.69	0.84	0.81	0.78	**0.74**
Overall	**0.69**	**0.76**	**0.81**	**0.67**	**0.69**

Decibel Levels

Decibel levels were averaged for each observation period and are displayed below (Table 3.8).

Table 3.8. Maximum, minimum, and average decibel levels for each observation period and overall.

	Max	*Min*	*Average Level*
Daytime	85.9	37.7	63.2
Control Nights	78.2	32.9	56.4
Sunset Safari	86.2	48.2	62.9
Overall	**86.2**	**32.9**	**60.8**

Sociality

Although sociograms are generally used for larger groups of animals, one is provided here for both Whipsnade Zoo and London Zoo to allow for visualization of the AI values and the strength of the relationships between the lions (Figure 3.9).

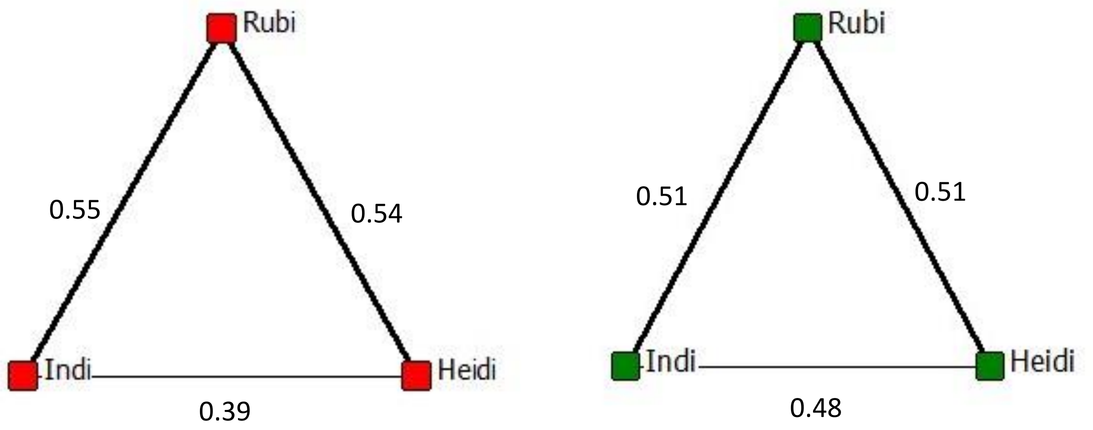


Fig. 3.9. Sociograms displaying the Association Index values for the relationship between the lions at Whipsnade Zoo (left) and London Zoo (right).

Personality

Personality questionnaires were completed in 2015 by seven keepers who worked with the lions at Whipsnade Zoo or London Zoo (Table 3.9).

Table 3.9. Summary of keepers who completed lion personality questionnaires in 2015.

Keeper	*Sex*	*Experience with these lions*	*Hours/week with the lions*	*Average range between ratings*
1	M	6 months	25+	2.5
2	M	6 years	8	2.0
3	F	3.5 years	3	1.8
4	M	5 years	2	1.1
5	M	3 years	7	2.2
6	M	6 years	10	1.5
7	M	6 years	8	1.9

Personality questionnaires for each female were highly reliable. For Rubi, the average measure intraclass correlation (ICC) was .761 with a 95% confidence interval from .577 to .886. For Heidi, the average measure ICC was .805 with a 95% confidence interval from .652 to .907. For Indi, the average measure ICC was .857 with a 95% confidence interval from .744 to .932. According to a published interpretation scale (Cicchetti, 1994), these are excellent ICC values.

Personality profiles for each female as determined by the questionnaires and behavioral observations are portrayed separately and combined below (Figures 3.10-3.12). The second and third charts are limited to eight traits as only behaviors fitting into those eight categories were observed. When considering Figure 3.10, the ratings for each female for each trait are relative to each other.

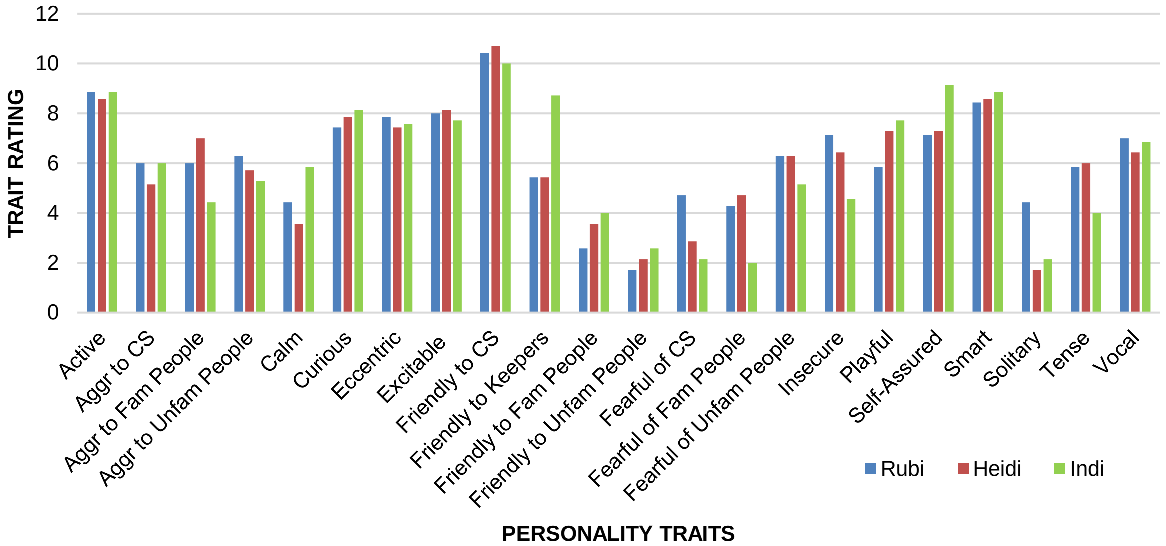


Fig. 3.10. Personality profiles for each female compiled from questionnaires completed by keepers. Aggr = Aggressive, Fam = Familiar, Unfam = Unfamiliar, CS = Conspecific.

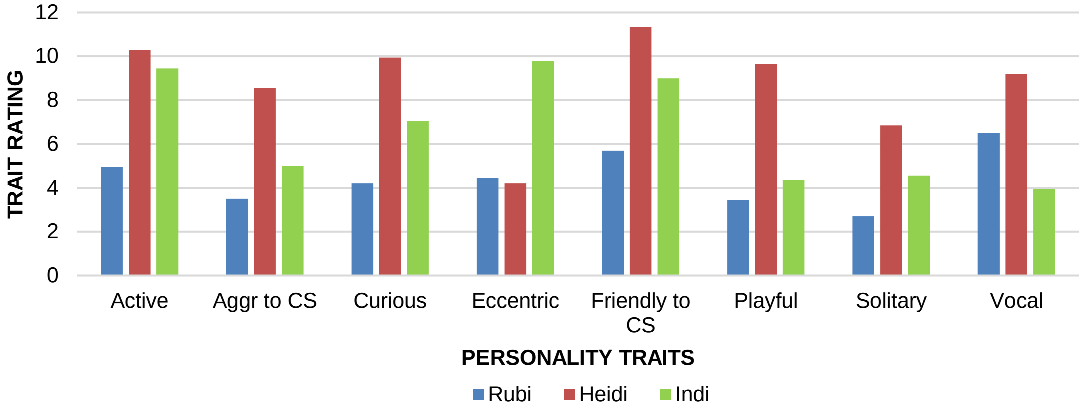


Fig. 3.11. Personality profiles for each female compiled from observation data. Aggr = Aggressive, CS = Conspecific.

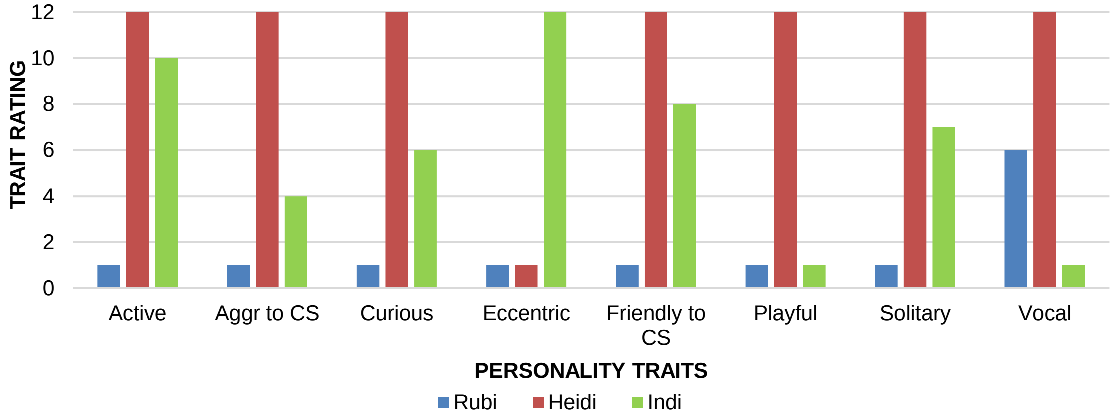


Fig. 3.12. Personality profiles compiled from both keeper questionnaires and observation data for each female. Aggr = Aggressive, CS = Conspecific.

3.5 DISCUSSION

Time Budget

Overall, the lionesses were inactive for the majority of the time (56.7%), with Rubi displaying the most inactivity (74.0%). The high percentage of inactivity is appropriate as wild lions can sleep up to 21 hours per day (Schaller, 1972). Indi displayed the most stereotypic behavior, which all occurred during daytime observations. However, the frequency of pacing decreased throughout the study. This could be due to a number of factors, such as gradual adjustment to the new enclosure or changes in enrichment or training practices. Previous research found that provision of new objects may lead to a reduction of stereotypic behavior (Carlstead *et al.*, 1993; Mellen and MacPhee, 2001).

Observed stereotypic behavior decreased from Whipsnade Zoo to London Zoo. Combining the females' daytime data, stereotypies comprised 24% of the Whipsnade time budget, while only 11% of the London time budget. In part, this may be related to the difference in enclosure size. Lyons *et. al.* (1997) suggest that cats kept in smaller enclosures paced more often than cats in larger enclosures. The females' London Zoo enclosure, at 1395 m^2, is notably larger than their Whipsnade Zoo enclosure (230 m^2), which may related to the decrease in stereotypic behavior.

Most of the lions' pacing at London Zoo occurred along a chain link fence on the edge of Zone 2. Lyons *et. al.* (1997) found that pacing occurred significantly more often along enclosure edges than in other areas. Other studies discussed that areas with fences, through which felids can see conspecifics, other animals, or humans, were associated with increased stereotypic behavior (Bashaw *et al.*, 2007; Clubb and Vickery, 2006). When the lions moved into the new enclosure, they could see the public on the walkway above this pacing location. The zoo eventually covered this area in an attempt to lessen the occurrence of stereotypies, but the lions may have already established a pacing routine. The lions also paced in front of a metal gate that divided enclosure sections, through which they could sometimes see Bhanu, but observations of this behavior were rare.

Much of the observed pacing behavior occurred before or after their morning feed. The post-feed stereotypic behavior could be due to a short feeding period, which implies that appetite behaviors were not fully expressed (Swaisgood and Shepherdson, 2006). Consequently, the pacing may have been a method to release frustration. Conversely, the stereotypies may originate from a previous stimulus and therefore be independent of any of the lions' experiences at this enclosure (Mason, 1991). Before the renovation of their London Zoo enclosure, the lions paced in a different area of Zone 1. According to Mason (1991), once stereotypies become a part of an animal's behavioral repertoire, their correlation with poor welfare may decrease over time. Therefore, the current pacing may be a "scar" from previous traumatic experiences (Mason, 1991). Because of this, the stereotypies observed during this study should not be exclusively considered a sign of current welfare concerns without further investigation into the possible causes of this behavior. Frequent use of varied enrichment may decrease pacing behavior in the lions, especially if the methods used are tailored to the needs or preferences of the individual lion (Swaisgood and Shepherdson, 2006).

Although lions are typically most active during morning and evening hours (Schaller, 1972), the females were more inactive during both evening observation periods than during daytime observations. This could be due to daytime observations starting at 8 am, when the lions tended to be active. In the middle of the day, the lions spent the majority of their time resting. Additionally, some of their daytime activity took place during training or scatter feeds, which would affect the amount of inactivity exhibited when left to behave naturally.

Time budgets varied little between control nights and Sunset Safaris. The lions were inactive for the majority of their time during Sunset Safaris, even with higher overall decibel levels during these events. Rubi and Heidi displayed more activity during Sunset Safari than control nights, but that may have been affected by multiple scatter feeds during one Sunset Safari and the addition of multiple new forms of enrichment to the enclosure before a separate Sunset Safari. This small difference in behavior displayed between observation periods is likely a positive indicator of adjustment to the evening social events. One instance of aggression toward the public occurred during the first Sunset Safari, in which Heidi banged on the glass in front of large group of visitors, at least one of whom was a young child. However, this was the only occurrence of aggression toward the public observed during Sunset Safaris.

Enclosure Use

During daytime observations, the lions spent most of their time in Zones 1-2, where they were mainly inactive. They likely designated these zones as the core area of their territory, in which they felt most secure, with the rest of the enclosure being used for other purposes (e.g., playing, exploration, and occasionally resting) (Liberg and Sandell, 1988). The lions spent a lot of time in this area before the enclosure was renovated, so their memory of this location may have influenced its current use.

The lions also spent a large portion of their time in Zones 12-13, which make up a raised platform in the original part of the enclosure. These zones gave them a higher viewpoint of the visitor areas and surrounding animal enclosures. Lyons (1997) found that big cats often used areas with higher viewpoints for resting and observing. Because the females spent a much of their time on this platform, the addition of a similar structure in the new part of the enclosure might increase the amount of time they spend in that area.

When considering the change in enclosure use over time, the lions used more of the enclosure as the study progressed. During Week 1, the lions were not observed in the new part of the enclosure, but were observed in that area with increasing frequency over time. This could partially be due to changed training and enrichment practices used in order to influence the lions' use of that area more often. Nonetheless, these husbandry practices may increase the lions' comfortability with that area and may lead to them using the new part of the enclosure more often on their own accord.

Similar to the time budget comparison, there was little difference between the lions' enclosure use during control nights and Sunset Safaris. The greater variety of zone use seen during Sunset Safaris may be related to multiple scatter feeds and addition of new enrichment during separate evenings, which caused increased movement through the enclosure. Zone 25, an area containing heated platforms for the lions and offering great viewing experience for visitors, was used more during control nights than during Sunset Safaris. Visitor sound levels and behavior (e.g., banging on the windows next to the heated rocks) may have influenced the lions to not spend much time there during Sunset Safaris.

SPI values demonstrate that the lions used the enclosure unevenly, which is supported by the charts separating enclosure use into original and new parts of the enclosure. However, the change in enclosure use over time suggests the lions may continue to spend more time in the new part of the enclosure. Overall SPI values were the same for Whipsnade Zoo and London Zoo. This uneven enclosure use reinforces the previously described idea of felids having core areas of their territory and has been similarly described in prides of wild lions (Schaller, 1972).

Sociality

Both sociograms indicates that Heidi and Indi have a slightly stronger bond with Rubi than with each other, but differences in AI values are minimal. Schaller found that there was no consistent lioness leadership of an African lion pride (Schaller, 1972). However, because Asiatic lion prides typically are smaller than those of African lions (Joslin, 1973), Indi and Heidi may look to Rubi for leadership as the eldest female of the pride, especially at Whipsnade Zoo when they may have been under increased stress post-move. This may explain why Indi and Heidi both tended to associate more with Rubi than with each other. Nevertheless, a longer study would provide a more complete image of the sociality between the females, including more robust AI values to indicate their social preferences.

Personality

The profiles created from keeper questionnaires do not differ much between the lions, which was not the expected result. However, the inter-rater reliability results show that the method is reliable, as has been found in other studies (Chadwick, 2014; Highfill *et al.*, 2010). These ratings can be dependent on keeper experience with the animals and existing knowledge of animal personality. Interestingly, the range between trait ratings showing the most distinction between females did not correspond to level of keeper experience. For instance, the three keepers with the largest ranges between ratings for females had anywhere from the least to most experience with the lions. Additionally, it can be difficult to distinguish between the lionesses, which may have impacted the quality of the profiles. These questionnaires were completed in 2015 while the lions were at Whipsnade Zoo. Since then, the questionnaires have been expanded to 31 traits. Ideally, the questionnaires would be repeated again for more complete personality assessments.

The personality profiles created from behavioral observations were affected by having three subjects and a small data set, which makes the difference in trait ratings appear as large deviations in personality between the three females. Rather, these profiles may best be viewed as the lion that exhibited the most, least, or mid amount of a trait. However, personality profiles from observations are a reliable and objective method that would be even more useful with a larger, long-term data set (Watters and Powell, 2012).

Previous events in the lions' lives may have greatly influenced the results of the personality questionnaires. In 2014, the females lost both of their parents within a few months. Shortly after this, they were transferred to Whipsnade Zoo. These experiences may have been traumatic for the lions and possibly have affected their behavior for an extended period of time. For example, the large amount of pacing behavior exhibited by the lions at Whipsnade may have been a response to these stressful events. As previously discussed, this pacing behavior may have carried over to the current study as a "scar" from these traumatic experiences (Mason, 1991).

Rubi had the highest average rating on keeper questionnaires for "Solitary," but comparatively Heidi was the most solitary according to observation data. This may be connected to Heidi's high ratings in "Curious" and "Playful" in that she often investigated or played with objects. For instance, after the addition of new enrichment to the enclosure, Heidi spent more time interacting with the items compared to her siblings. Considering Heidi's time budget, she also exhibited more "Exploratory" behavior than her sisters. This increased time exploring and interacting with objects may indicate that she spent less time near her sisters, therefore increasing her rating for "Solitary."

As expected considering the lions' time budgets, Indi had the highest rating for "Eccentric" on her profile created from observation data, which is due to her exhibiting the most stereotypic behavior. Before moving to Whipsnade Zoo, Rubi was the first lionesses to begin pacing after the loss of their parents. Heidi and Indi soon joined Rubi in this behavior, which then continued at Whipsnade Zoo. The fact that they followed Rubi in her display of stereotypic behavior may be an example of social facilitation, and would support the aforementioned idea of Rubi as the leading female of the pride. Conversely, during observations at London Zoo, Indi often initiated the pacing behavior, and sometimes Rubi and/or Heidi would join her. Evidently, pride sociality plays a role in their behavioral patterns and preferences, but that role may be dynamic depending on their circumstances.

The personality profiles create opportunities for more individualized management of the lions, as demonstrated by Gartner and Powell's study on snow leopard personality (2012). They suggest that shier animals may need more places to hide, while bolder animals may benefit from increased enrichment opportunities. Heidi, as the most playful and curious of the three, may benefit from increased enrichment opportunities. Indi, as the most prone to eccentric behavior, may benefit from the same management strategies, but in order to decrease stereotypic behavior. Furthermore, with a longer study period and repeated questionnaires, it may be possible to determine which of the females would be the best option to breed, as previously demonstrated in cheetahs (Chadwick, 2014; Wielebnowski, 1999).

These conclusions are anecdotal, but they do stem from observations and the valuable perspectives of the keepers. In the past year, some of the keepers have spent more time with the lions and may be better able to distinguish personality differences between the females. Although personality is consistent overtime, the questionnaires may have been influenced by previous traumatic events and by keeper knowledge of the animals. Now that the lions have settled into Land of the Lions and the questionnaires have been expanded, it would be ideal to repeat the questionnaires.

Limitations and Future Research

This study was limited by its small data set. A longer study period would allow for more reliable personality profiles to be created based on observations, thus making an excellent complement for the profiles generated from keeper questionnaires. Additionally, it would be interesting to measure fecal cortisol levels while conducting observations to determine if a correlation exists between cortisol levels and certain behavioral patterns (Carlstead *et al.*, 1993).

Currently there are camera traps posted around the Land of the Lions recording the lions' activity. This data will provide a 24-hour time budget, which may reveal interesting and yet unnoticed behavioral patterns. A personality study of all captive Asiatic lions would enable a comparison of lion personality across a variety of captive management systems and further development of methodologies for felid personality research. This would also provide an opportunity to analyze keeper ratings based on their experience with the animals and personality research.

3.6 CONCLUSIONS

This research provided valuable behavioral and personality profiles for the lionesses at London Zoo.

There was little difference in behavioral data between Sunset Safaris and control nights, which may be an indicator of little negative impact on the lions because of increased human social interaction.

The personality questionnaires were found to be a reliable method of assessing personality. The personality profiles created by keeper questionnaires showed little difference between the females, therefore making individual comparisons difficult. However, the profiles created from behavioral observations showed more of a distinction between the lions. Combined together, these profiles offer some opportunities for individualized management of the lions, including varied enrichment methods.

This research provides useful information for these specific lions to support current and future management decisions, and an interesting case study on individual animal adjustment to new environments.

4. SUMATRAN TIGERS MONITORING DURING ZSL LONDON ZOO EVENTS

4.1 ABSTRACT

The main focus of this research is to investigate the response of a large carnivore, Sumatran tiger in the zoo environment, during evening events.

Animal response is behavioural as well as physiological and the zoo environment includes climatic, intraspecific and interspecific contact and nutritional factors that can vary significantly from the in situ habitat where the species evolved.

Ex situ intraspecific contact can be quite different for tigers that are mainly solitary in the wild but are often housed in couples or larger groups in zoos; interspecific contact varies as well since animals have daily contact with humans such as keepers and visitors, and other animal species.

Monitoring these responses is essential to animal welfare and offer insight of the species' behaviour and ex situ adaptability ,producing valuable data relevant for their husbandry.

For this project we monitored a group of Sumatran tigers (*Panthera tigris sumatrae*) comparing their behaviour during evening social events (Zoo late Nights and Sunset Safari) and control evening during Summer 2014 and 2015.

During Zoo Lates the potential number of visitors per hour to an enclosure was more than twice that on an average day in August. Maximum noise levels measured in Gorilla Kingdom (GK) were approximately 10dB higher on Zoo Lates compared to control evenings and flash photography regularly occurs.

Direct observations indicate that the behaviour of these species was not significantly altered on Zoo Lates.

4.2 INTRODUCTION

Several researchers have reported significant effects of visitor density (number) and intensity (noise level) on captive animal behavior (Sellinger and Ha, 2005). Studies correlating human effects to behavior have been conducted—with varying results—on several species. Chamove, Hosey, and Schaetzel (1988) found that visitors increased the activity level of primates, increased the level of aggressive behavior,and decreased nonviolent social behavior. A study of wild tigers (Kerley *et al.*, 2002) found that tigers consumed more meat and spent more time at kill sites that were undisturbed by humans. Margulis, Hoyos, and Anderson (2003) studied 6 different species of felids (lion, amur leopard,amur tiger, snow leopard, clouded leopard, and fishing cat) in captive environments and found that the presence of visitors had no effect on any of the species studied; the same results were found for captive cheetahs (O'Donovan, Hindle, McKeown, & O'Donovan, 1993). However, Mallapur and Chellam (2002) found that visitors affected the behavior of captive Indian leopards. A study performed by Sellinger and Ha (2005) showed that the jaguars at the Woodland Park Zoo (WPZ) in Seattle, Washington, were reacting to the intensity and density of visitors to the exhibit, with a trend toward increased amounts of pacing and aggression, particularly for the female jaguar. Szokalski *et al.* (2013) observed the behavior of one Sumatran tiger (*Panthera tigris sumatrae*) and three African lions (*Panthera leo leo*) involved in a protected contact tour, as well as that of three cheetahs (*Acinonyx jubatus*) involved in a hands-on tour, at Zoos South Australia. The animals in the protected contact tour displayed decreased inactivity and increased feeding and pacing during the tours, compared to before and after. The authors suggest that the increased pacing was more associated with the animals being fed during the tours, rather than the tours being a stressful experience. Cheetahs involved in the hands-on tour showed variation in proportions of multiple behavior categories and primarily these were shifts in species-typical behaviors. In contrast to the tiger and lions in the protected contact tour, cheetahs showed decreased pacing during the tour sessions. No aggressive or otherwise antagonistic behaviors directed at humans were observed by animals in either tour, with these animals typically spending more than half of their tour times in distant proximity to keepers and visitors.

Based on previous literature on the effect of public on captive felids we hypotheses that evening social event in London zoo (2014 Zoo late nights and 2015 Sunset safari) did not have a significant impact on the baseline activity budget (measured during control evenings) of the resident Sumatran tigers.

Sumatran tigers

Sumatran tigers are the smallest surviving tiger subspecies and are distinguished by heavy black stripes on their orange coats. The last of Indonesia’s tigers—as few as 400 today—are holding on for survival in the remaining patches of forests on the island of Sumatra. Accelerating deforestation and rampant poaching mean this noble creature could end up like its extinct Javan and Balinese relatives. In Indonesia, anyone caught hunting tigers could face jail time and steep fines. But despite increased efforts in tiger conservation—including strengthening law enforcement and antipoaching capacity—a substantial market remains in Sumatra and the rest of Asia for tiger parts and products. Sumatran tigers are losing their habitat and prey fast, and poaching shows no sign of decline (worldwildlife.org).

4.3 Materials and Methods

Enclosure: Tiger Territory

Tiger Territory is ZSL London zoo enclosure dedicated to Sumatran tigers. The exhibit has been designed with ZSL’s team of tiger keepers, conservationists and experts to ensure that it perfectly suits the big cats’ needs. The exhibit features tall trees for the cats to scale and high feeding poles to encourage their natural predatory behaviours. The European breeding programme and the Global Management Species Programme for Sumatran tigers are both coordinated by ZSL London Zoo – where ZSL’s specialists are responsible for ensuring a healthy and diverse population of tigers in zoos around the world.

ZSL London Zoo Tigers

A group of five Sumatran tigers (*Panthera tigris sumatrae*) were the focus of behavioural investigations during the nine evenings of Zoo Lates, from June 6th to August 1st 2014 and seven Sunset Safari nights from June the 5th to July 17th 2015 (Table 4.1).

Sex	**Name**	**Age in 2014**	**Age in 2015**
Male	1 Jae jae	6 years	7 years
Female	2 Melati	6 years	7 years
Female	3 Cinta	4 months	16 months
Male	4 Budi	4 months	16 months
Male	5 Nakal	4 months	16 months

Table 4.1. Sumatran tigers monitored in this study

Born in San Francisco Zoo, Jae Jae moved to Akron Zoo, Ohio with his brothers Kami Sambol, and Burung when they were all a year old. In autumn 2012, Jae Jae was tranfered to ZSL London Zoo to meet female tiger Melati (from Perth zoo) as part of the global breeding programme for this critically endangered species. On 3 February 2014, Jae Jae sired Nakal, Budi and Cinta – vital additions to the international breeding programme for this critically endangered species. The trio were moved to other zoos at the beginning of 2016 to start their own breeding groups.

Fig. 4.1. Jae Jae, London zoo male Sumatran tiger

Fig. 4.2. From top to bottom: Melati, Cinta, Budi and Nakal ; London zoo adult female and cubs Sumatran tiger

The aim of this research was to determine the following with a view to evaluating the potential animal welfare effect and mitigation options;

- Are there differences in levels of anxiety-related behaviours (stereotypies, self-directed behaviours and aggression) performed on Zoo Lates v baseline evenings?
- What is the difference in noise levels on Zoo Lates v baseline evenings?
- Identification of potential triggers for expression of anxiety related behaviours ?

Data collection

Data was collected in the following conditions;

- 1800-2130 hours during 9 x Zoo Late nights (7 in 2015)
- 1800-2130 hours during 9 x baseline nights during the Zoo Lates period (7 in 2015)

Behaviour

Each data collection evening was divided into four time sessions; 1800-1850, 1850-1940, 1940-2030 and 2030-2120 hours. In each time slot, all individuals were observed using focal sampling; observing one individual at a time for 9 minutes (according to the group size), recording state behaviors every minute (on the minute) and all occurrences of event behaviors recorded during each 9minute session. The order in which each animal was observed was randomized. An appropriate ethogram was constructed to categories species appropriate state and event behaviours.

On baseline evenings, the same behavioural data collection methods were used as outlined above. The criteria for conducting baseline observations were that they were conducted under similar environmental, weather and husbandry conditions, with minimal external influences.

Noise levels and flash photography disturbance

In additional to behavioral observations, researchers took maximum and minimum decibel readings at the end of each data collection session (using Mini Sound Level Meters). The total number of camera flashes occurring during each data collection session was also recorded.

Crowd size (number of visitors within 5 meters of the exhibit) was recorded every minute (on the minute) during each sampling session, and recorded in 3 categories; low (0-20 people), medium (20-50 people), and high (50+ people).

Enclosure use

Each exhibit was divided into zones to determine enclosure use. The zone number that the focal animal was located in was recorded every minute (on the minute) during each sampling session. Although collected, these data have not been analyzed for this report.

Data analysis

Noise levels were determined as an average of the maximum decibel reading taken in each session, for each evening for both Zoo Lates and baseline nights. Sleep/ off show times were calculated as an average for all Zoo Late and baseline nights, including the range of timings over all evenings per individual.

Photographic flashes were calculated as an average number per time session.

Performances of state behaviors were determined as a proportion of time performed when the animals were in sight, whilst event behaviours were calculated as an average rate per minute. Data were analyzed using Generalised Linear Mixed Models (GLMM) using SPSS 21 (IBM, 2014) with an inverse Gaussian distribution and log link function. Factors of condition (Zoo Lates or baseline) and individual were applied to the group data, when analyzing individual data, the factors condition, time session and an interaction between these factors were analyzed. We fitted the models using a backward elimination process to find the minimum adequate model for explaining the variance of the response variable. Only significant explanatory variables and two-way interactions were retained and models with the lowest finite sample corrected AIC (AICC) value were interpreted. For all significant results ($P < 0.05$), post-hoc pairwise comparisons with Bonferroni corrections were carried out and all relevant results are reported.

Due to the small sample size for the majority of behavioral data, findings are presented as descriptive or graphical illustrations.

4.4 RESULTS

Visitor attendance

The average number of visitors during the day (10:00 – 18:00) over two weeks this August (4th to 17th) was 6244. Therefore; the potential number of visitors the animals could be exposed to per hour was higher on Zoo Lates evenings compared with daytime visitor numbers; with less than 10 visitors present (keepers, researchers and stragglers leaving the zoo) on baseline evenings (Table 4.2).

Condition	Average n. visitors per hour
During day	780
Zoo Lates	1676
Baseline	< 10

Table 4.2. Average potential n. visitors viewing exhibit per hour during each condition.

Visitor numbers to Zoo Lates have increased annually since its inception in 2011 (Table 4.3). In 2014 the average number of visitors per evening was 6705.

Zoo Late	2011	2012	2013	2014	2015 (SS)
1	4293	3546	5872	5894	4040
2	5413	5590	6626	7135	3037
3	4096	5154	7071	6442	3463
4	5439	6006	6486	6524	3007
5	3804	6702	6720	7000	3799
6	5570	7215	6752	7310	4893
7	5395	7224	6727	7066	4846
8	6521	6837	6653	6240	na
9	6446	5594	6900	6730	na
TOTAL	46977	53868	59807	60341	27085
Av. no visitors/ evening	**5220**	**5985**	**6645**	**6705**	**3869**

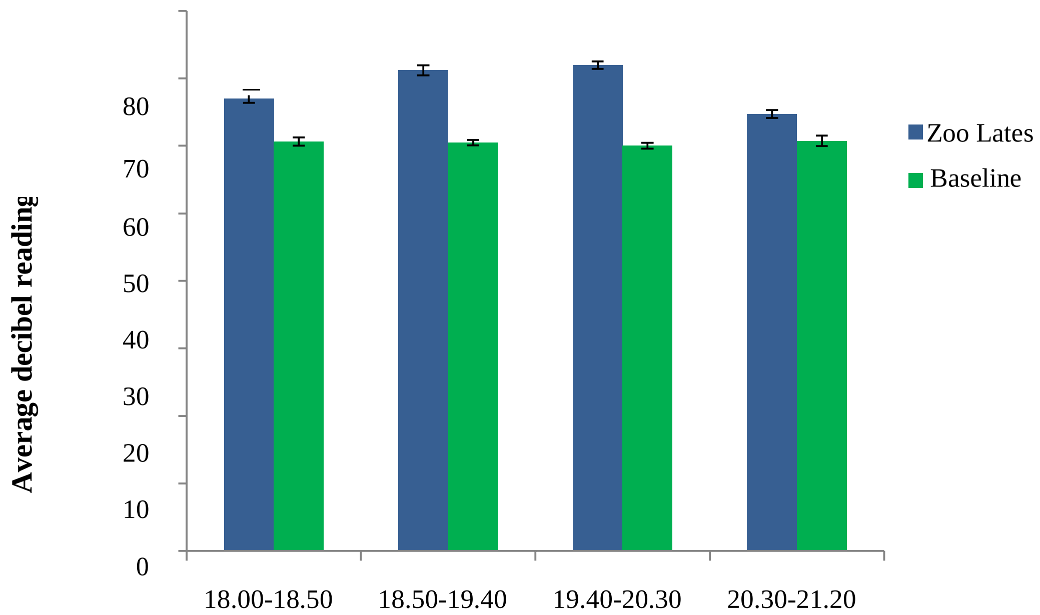
Table 4.3. Visitor numbers too Zoo Lates per year(SS=Sunset Safari); Sunset Safari nights were designed to be more family-orientated and less crowded events compared to previous zoo lates. Alcoholic drinks were not allowed and fewer tickets were printed.

Noise level

Only the results of decibel (dB) readings taken by the researcher based in Gorilla Kingdom (where the gorilla, spider monkeys and colobus monkeys were located) are presented, but a similar trend was noted at the location of each study species. Noise levels increased during the evening from 18.00 to 20.30 hours, then decreased when Gorilla Kingdom was closed to the public on Zoo Late evenings. Background noise was higher on Zoo Late evenings compared to baselines due to music and entertainment from nearby areas. During time period 18.30–20.30, 70 decibels was exceeded on 13 of 18 Zoo Late evenings (Table 4.4). Baseline decibel levels were lower and more consistent throughout the evening (Figure 4.3) averaging, 60,42 dB. It is likely that levels of 70 dB are reached during the day but this was not determined.

Zoo Late	18.00-18.50		18.50-19.40		19.40-20.30		20.30-21.20	
	Zoo	Baselin	Zoo	Baselin	Zoo	Baselin	Zoo Late	Baseli
1	67.98	62.50	71.78	60.80	68.98	60.58	64.20	59.90
2	68.10	63.35	72.33	63.60	71.93	61.55	71.35	60.43
3	67.10	62.18	71.75	61.97	75.88	60.73	67.43	60.73
4	67.40	56.50	70.20	57.78	72.28	59.73	63.25	58.08
5	66.58	62.08	70.73	61.10	73.83	58.68	64.23	55.63
6	68.08	59.00	77.13	60.15	73.60	59.05	63.78	61.30
7	68.15	59.30	73.48	59.38	72.53	59.03	62.23	63.60
8	63.25	59.98	63.00	59.00	69.50	58.05	No data	64.03
9	65.85	60.70	69.98	60.65	68.80	62.65	64.58	61.28
Average dB reading	**66.94 (60-74.2)**	**60.62**	**71.15 (60-79.3)**	**60.49**	**71.92 (65-78.4)**	**60.01**	**64.71 (57.773.7)**	**60.55**

Table 4.4. Average maximum decibel readings per time session on Zoo Lates and baseline nights (2014)



Sessions

Figure 4.3. Average decibel reading in each time session on Zoo Late and baseline evening (2014)

Flash photography

Flash photography was a common occurrence in all areas of the zoo during the events but in Tiger Territory it is thought to be a trigger to Melati's hissing behavior and her moving to enclosure's areas farer from visitors and camera flashes. The number of flashes per observation session was higher in the end time periods (20.30-21.20) probably because at that time light was becoming dimmer. It was noted that often visitors did not realise that their flash setting was turned on.

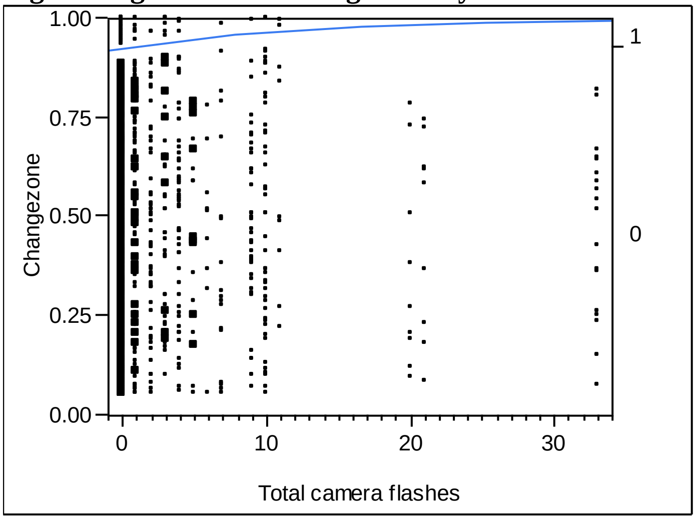
	Zoo Late				Baseline
	18.00-18.50	18.50-19.40	19.40-20.30	20.30-21.20	
Average number of camera flashes per 15 minutes (range)	1.45 (0 to 5)	1.87 (0 to 9)	2.1 (0 to 11)	0.67 (0 to 5)	0

Table 4.7. Average number of camera flashes in Tiger Territory on Zoo Late (per time session) and baseline nights (2014)

Enclosure usage

The probability of changing a zone of a subject in the 9-minute period of observation was analyzed by a logistic regression model (Freedman, 2009). The logistic regression is generally defined as a binary logistic model used to estimate the probability of a binary response based on one or more predictor (or independent) variables (Walker and Duncan, 1967). The independent variables (4) taken into account were the total camera flashes (in 9 minutes), the maximum of the acoustical power (in dB) during the 9-minute period, the minimum of the acoustical power (in dB) during the 9-minute period, and the difference between the maximum dB value and the minimum dB value in the same period (delta dB). Moreover, three qualitative variables were included in the model: the animal, the crowd size, classified as low, medium, and high, and the year (2014 or 2015). The "risk" of changing a zone for each variable was quantified by the unit odds ratio, which indicates the average "risk" of a moving, given the variation of a unit of the independent variable (e.g. moving after 9 flashes respect to 8 flashes in 9-minute observation.

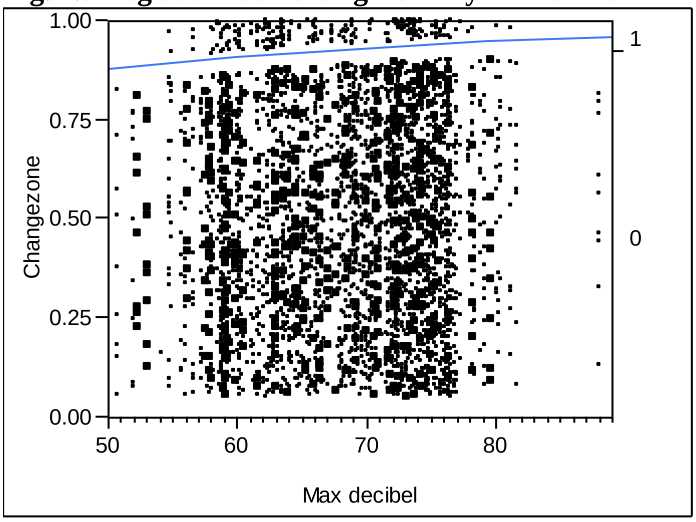
Fig.4.4 Logistic Fit of Changezone By Total camera flashes



Parameter Estimates

Term	**ChiSquare**	**Prob>ChiSq**	**Unit Odds Ratio**	
Intercept	1403.7	<.0001	.	.
Total camera flashes	4.05	0.0441	1.08375952	

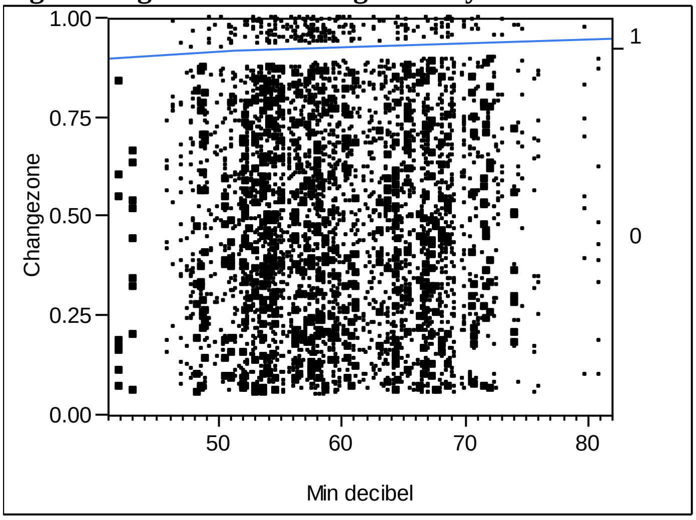
Fig. 4.5 Logistic Fit of Changezone By Max decibel



Parameter Estimates

Term	**ChiSquare**	**Prob>ChiSq**	**Unit Odds Ratio**	
Intercept	0.43	0.5099	.	.
Max decibel	9.90	0.0017	1.03165626	

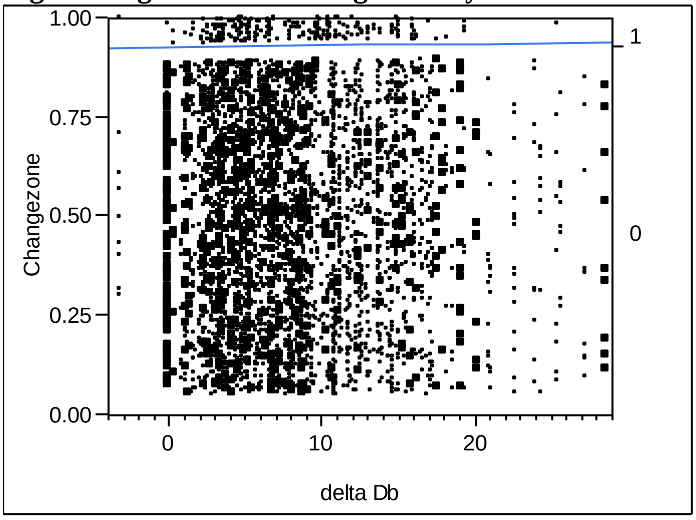
Fig. 4.6 Logistic Fit of Changezone By Min decibel



Parameter Estimates

Term	**ChiSquare**	**Prob>ChiSq**	**Unit Odds Ratio**
Intercept	6.30	0.0121	.
Min decibel	3.66	0.0558	1.01872723

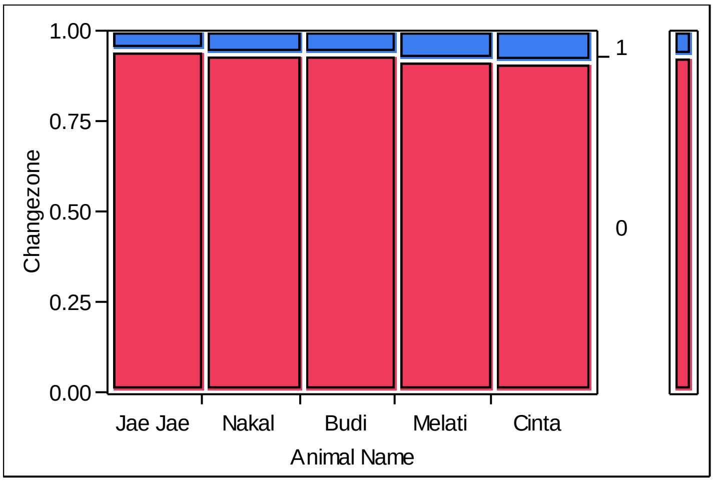
Fig. 4.7 Logistic Fit of Changezone By delta Db



Parameter Estimates

Term	**ChiSquare**	**Prob>ChiSq**	**Unit Odds Ratio**
Intercept	441.54	<.0001	.
delta Db	0.33	0.5662	1.00722911

Fig. 4.8 Contingency Analysis of Changezone By Animal Name
Mosaic Plot

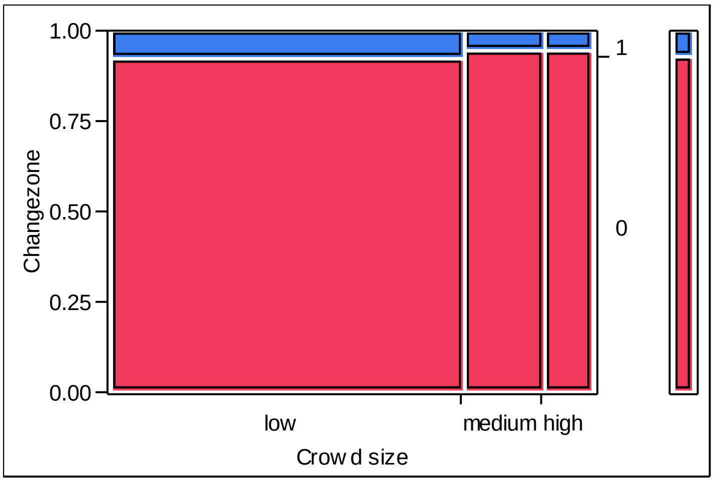


Contingency Table

	Change zone		
Count Row %	0	1	
Jae Jae	656 94.66	37 5.34	693 19.80
Nakal	665 93.53	46 6.47	711 20.31
Budi	648 93.51	45 6.49	693 19.80
Melati	646 92.02	56 7.98	702 20.06
Cinta	642 91.58	59 8.42	701 20.03
Total	3257 93.06	243 6.94	3500

Test	**ChiSquare**	**Prob>ChiSq**
Likelihood Ratio	6.784	0.1477
Pearson	6.741	0.1503

Fig. 4.9 Contingency Analysis of Changezone By Crowd size
Mosaic Plot

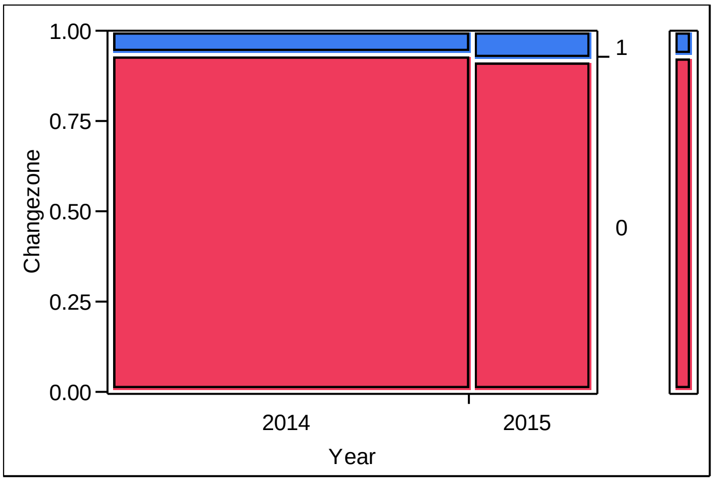


Contingency Table

Count Row %	Change zone 0	1	
low	2382 92.50	193 7.50	2575 73.57
medium	545 94.62	31 5.38	576 16.46
high	330 94.56	19 5.44	349 9.97
Total	3257 93.06	243 6.94	3500

Test	**ChiSquare**	**Prob>ChiSq**
Likelihood Ratio	4.834	0.0892
Pearson	4.601	0.1002

Fig. 4.10 Contingency Analysis of Changezone By Year
Mosaic Plot



Contingency Table
Change zone

Count Row %	0	1	
2014	2461 93.36	175 6.64	2636 75.31
2015	796 92.13	68 7.87	864 24.69
tot	3257 93.06	243 6.94	3500

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	1.488	
Pearson	1.528	0.2165

RESULTS

The logistic model applied underlined the significance of several variables on the displacement of subjects. In particular, the total camera flashes and the maximum decibels resulted statistically significant, whereas the minimum decibels were borderline for significance. No effect was observed for the delta dB. Noise and flashes overall increase the risk of zone change in the enclosure. Qualitative variables (subject, crowd, and year) did not influence the displacement, although a slight difference between subjects can be observed. Surprisingly, the higher displacement frequency was noted when the crowd was classified as "low". No effect of year was calculated.

The distribution of the subjects on the zones for the three degrees of crowd was analyzed by the chi-square test.

Contingency Analysis of Zone By Crowd size
Mosaic Plot

TOTAL SUBJECTS
Crowd size By Zone

Row %	0	1	10	2	3	4	5	6	7	8	9	E	IN	LIN	oos
Low	5.32	2.17	9.40	0.43	2.17	1.55	6.68	7.84	12.74	13.98	6.60	8.35	5.63	1.40	15.73
medium	4.69	1.74	2.43	0.17	1.74	0.00	4.51	6.77	15.45	6.25	0.00	13.37	0.00	9.38	33.51
High	0.28	0.57	0.00	0.00	0.28	1.99	11.11	13.96	6.84	0.28	0.00	38.75	0.00	5.13	20.80

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	801.886	<.0001
Pearson	736.565	<.0001

Where(:Animal Name == "Jae Jae")

Contingency Analysis of Zone By Crowd size

Contingency Table

Crowd size By Zone

Row %	0	1	10	2	3	4	5	6	7	9	IN	LIN	oos
low	22.76	1.43	21.33	1.08	3.05	2.51	3.41	6.81	17.38	2.33	11.11	6.45	0.36
medium	23.28	5.17	10.34	0.00	0.00	0.00	0.00	0.00	14.66	0.00	0.00	46.55	0.00
high	4.76	0.00	0.00	0.00	0.00	0.00	9.52	0.00	0.00	0.00	0.00	85.71	0.00

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	225.231	<.0001
Pearson	236.345	<.0001

Warning: 20% of cells have expected count less than 5, ChiSquare suspect.

Where(:Animal Name == "Nakal")

Contingency Analysis of Zone By Crowd size

Contingency Table

Crowd size By Zone

Row %	1	10	2	3	4	5	6	7	8	9	E	IN	oos
low	3.47	5.21	0.00	0.97	1.16	5.21	12.16	12.36	17.37	10.42	10.23	2.90	18.53
medium	0.00	0.00	0.81	4.84	0.00	0.81	7.26	10.48	5.65	0.00	16.94	0.00	53.23
high	0.00	0.00	0.00	0.00	2.90	0.00	10.14	1.45	0.00	0.00	47.83	0.00	37.68

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	227.275	<.0001
Pearson	205.474	<.0001

Warning: 20% of cells have expected count less than 5, ChiSquare suspect.

Where(:Animal Name == "Budi")

Contingency Analysis of Zone By Crowd size

Contingency Table

Crowd size By Zone

Row %	1	10	3	4	5	6	7	8	9	E	IN	oos
low	0.42	0.84	2.11	2.11	9.70	7.59	16.03	20.46	7.59	11.60	3.59	17.93
medium	0.00	0.00	0.00	0.00	9.45	3.94	18.11	6.30	0.00	14.17	0.00	48.03
high	0.00	0.00	0.00	0.00	28.26	9.78	7.61	0.00	0.00	34.78	0.00	19.57

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	183.924	<.0001
Pearson	162.365	<.0001

Warning: 20% of cells have expected count less than 5, ChiSquare suspect.

Where(:Animal Name == "Melati")

Contingency Analysis of Zone By Crowd size

Contingency Table

Crowd size By Zone

Row %	0	1	10	2	3	4	5	6	7	8	9	E	IN	oos
low	0.79	2.77	14.03	0.40	1.38	0.79	9.09	4.55	7.91	10.28	5.53	12.06	9.29	21.15
medium	0.00	1.83	1.83	0.00	3.67	0.00	11.01	16.51	16.51	7.34	0.00	18.35	0.00	22.94
high	0.00	0.00	0.00	0.00	1.15	5.75	4.60	25.29	18.39	1.15	0.00	37.93	0.00	5.75

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	204.860	<.0001
Pearson	182.345	<.0001

Warning: 20% of cells have expected count less than 5, ChiSquare suspect.

Where(:Animal Name == "Cinta")

Contingency Analysis of Zone By Crowd size

Contingency Table

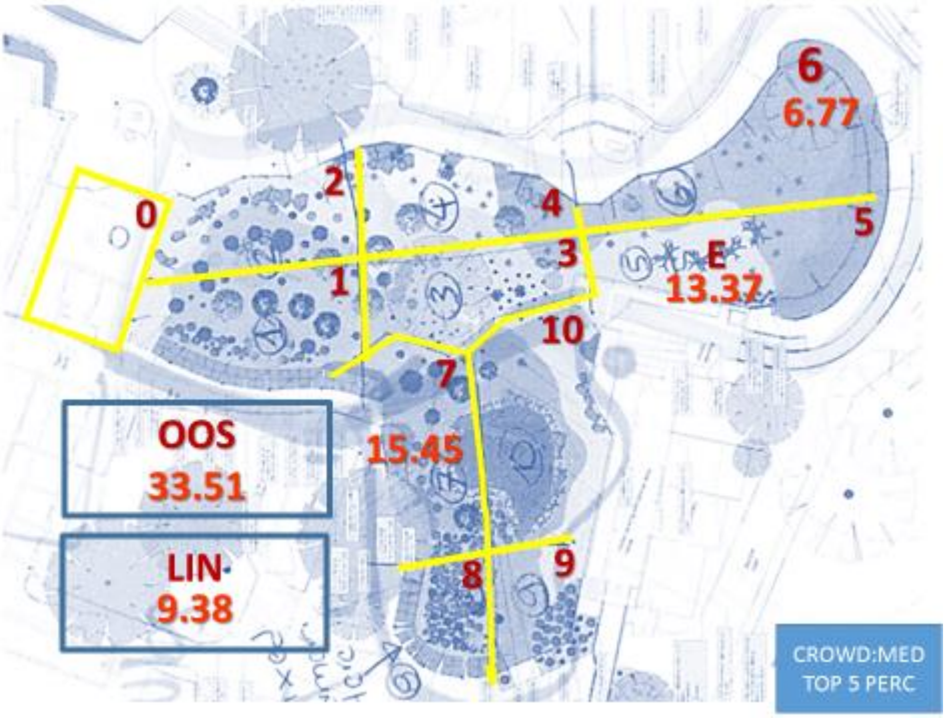
Crowd size By Zone

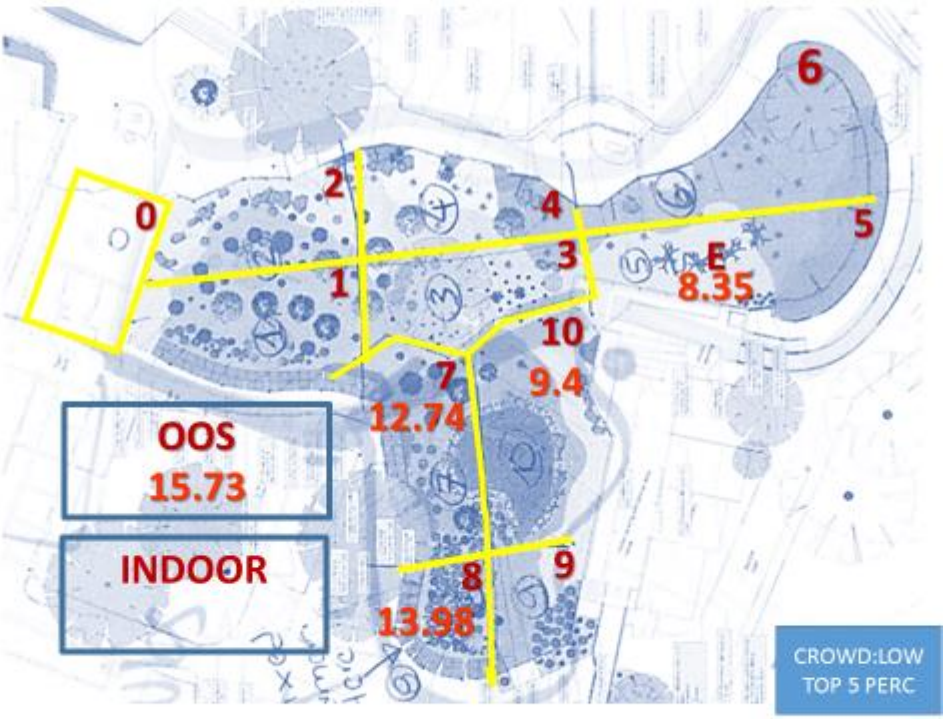
Row %	0	1	10	2	3	4	5	6	7	8	9	E	IN	oos
low	1.16	2.70	4.05	0.58	3.28	1.16	6.55	8.09	9.83	23.31	7.51	8.86	0.77	22.16
medium	0.00	2.00	0.00	0.00	0.00	0.00	1.00	7.00	18.00	13.00	0.00	18.00	0.00	41.00
high	0.00	2.44	0.00	0.00	0.00	0.00	8.54	13.41	0.00	0.00	0.00	46.34	0.00	29.27

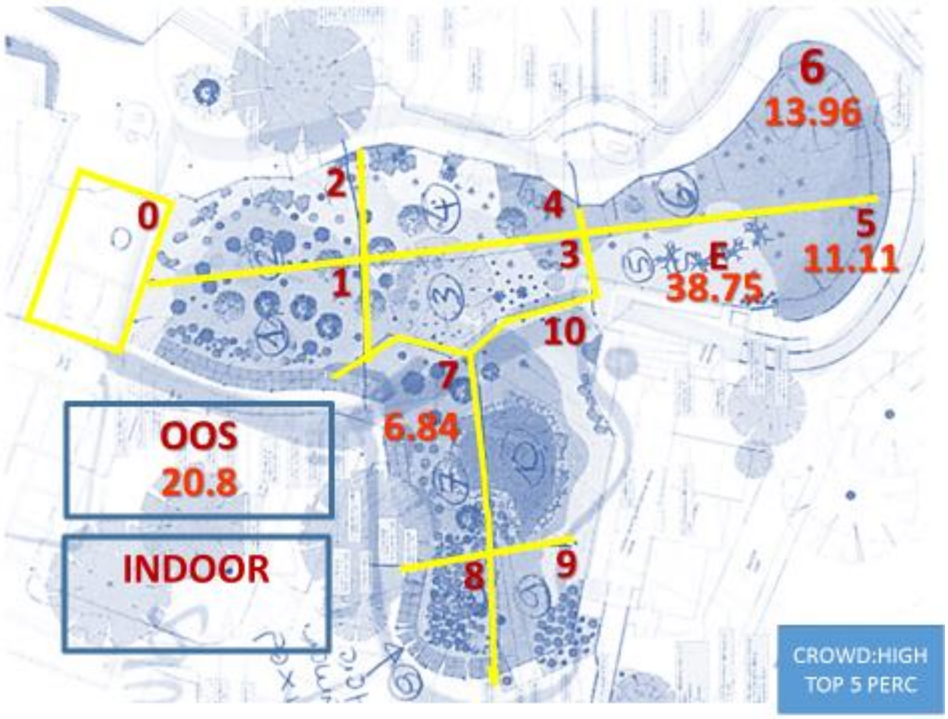
Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	188.121	<.0001
Pearson	160.438	<.0001

DISTRIBUTION OF THE TOTAL OF THE SUBJECTS AS A FUNCTION OF CROWD DENSITY (LOW, MEDIUM OR HIGH)

In the following schemes, the percentage of the distributions of the total of the observations are reported, limited to the 5 higher values. In red the zone number is reported, and in orange the percentage of permanence







4.5 CONCLUSIONS

From the data presented and discussed in this report emerges that tigers' behaviour was not significantly altered by visitors' presence or high noise levels. There is also a little difference between 2014 Zoo late nights and 2015 Sunset Safaris in terms of chance for a tiger to change zone inside the enclosure (fig. 4.10). This seems to confirm Margulis *et al.* (2003) results on 6 different species of felids in captive environments that found that the presence of visitors had no effect on any of the species studied.

On the other hand increase of total camera flashes seems to cause an increase in probability of a tiger to switch from a zone to another (moving away from camera flashes) as shown in figure 4.4.

Remarkably each tiger has a different probability of changing zone (fig.4.8) with Jae Jae being the less likely to switch zone and Cinta the most likely. This data reflects the behavioral and personality differences between this group of tigers and point at the relevance that personality in each animal's individual response to surrounding environment.

Further research in zoo animals personality is therefore auspicious in order to better design and ameliorate human/animal interactions during public events.

5. PERSONALITY AND SOCIALITY OF CAPTIVE ANIMALS: BEHAVIOUR AND PERSONALITY OF BEARS IN WHIPSNADE ZOO

5.1 ABSTRACT

Behavioural observations were conducted on brown bears, *Ursus arctos arctos,* and sloth bears, *Melursus ursinus inornatus,* in order to observe captive behaviour and create personality profiles for each individual. Behaviour was monitored creating an ethogram in order to produce activity budgets ,identify zone usage and social behaviour. Behaviour monitoring allowed to discover possible stereotypic behaviours and evaluate the welfare of the animals. Personality profiles were created with behavioural observations and with questionnaires that were given to the keepers to produce two personality profiles for each individual using these two different data sources. The behavioural observations indicated a number of stereotypic behaviours from sloth bears but not brown bears. The uniformity of zone usage was calculated to indicate if the enclosure size and features were adequate for use, and a social aspect of solitary animals was also identified. The personality profiles were compared between the results of the questionnaire and the behavioural observations for each individual but not compared between the different individuals since the methods were used to test the validity of the methodology to ascertain if it could be applied to bears. This is because this study is not a comparison between different personality types but an effort in creating valid methodology in order to assess personality in bears since very little is available in the current literature.

5.2 INTRODUCTION

Among the methods to evaluate animal personality is by acquiring trait ratings asking handlers, keepers or other people that have frequent contact with the animal/s tested to evaluate their personality (Gosling, 2008) or by behavioural coding, where observations are made on the behaviours exhibited by the animals (or according to their reaction to specific tests) (Chadwick, 2014).

The Big Five personality traits, also known as the five factor model (FFM), is another model based on common language descriptors of personality (Goldberg, 1993; wikipedia.org). These descriptors are grouped together using a statistical technique called factor analysis. This widely examined theory suggests five broad dimensions used by some psychologists to describe the human personality and psyche (Goldberg, 1993; Costa and McCrae, 1992). The five factors have been defined as openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism. The NEO-FFI was adapted for use in non-human animals using traits more suitable to this animal group (Highfill and Kuczaj, 2007). After the initial adaptation, other studies have tried to adapt the NEO-FFI to other species (Uher, 2008) or alternatively used statistical tools, like the Principal Component Analysis (PCA), to make their own domains of personality (Chadwick, 2014). In this study the personality domains adapted for animals will be used in an effort to create personality profiles for each individual (Birgersson, 2011; Highfill and Kuczaj, 2007).

Personality studies are important because they can be useful to develop a more effective captive management regime in zoos (Gartner and Weiss, 2013), by increasing the welfare of individuals by accommodating some needs that may be more suited to their personality type.(Tetley and O'Hara, 2012).

Personality also plays a role in reproductive success in zoos for a number of species. A study by Chadwick (2014) examined the effect of personality on cheetah reproductive pairs, promoting the use of personality profiles to make matches between individuals that will have higher reproductive success (Gartner and Weiss, 2013). This in turn increases the welfare of the animal because it allows to forecast a potential successful match before the relocation of animals occurs (Chadwick, 2014), reducing the chance of potential mismatched which results in low or no reproductive success (Wells *et al.*, 2004).

Sri Lankan sloth bears are endemic to Sri Lanka with very low numbers that are decreasing. Brown bears are not threatened yet but are decreasing in numbers and have become extinct from most of their historical range (Servheen *et al.*, 1999). Both species are in need of conservation efforts.

This is a pilot study where different methods used in the literature will be tested for validity and reliability in regards to brown and sloth bears (Uher, 2008). Currently only one research paper on bear personality exist (Fagen and Fagen ,1996).

The authors found that individual brown bears, *Ursus arctos*, behave differently from each other. They suggest that consistent behavioural differences imply that each bear has its own distinct personality. The study was carried out on Admiralty Island in south-eastern Alaska, where longitudinal data was collected during three years of summer salmon runs on seven individual brown bears that could be recognized from year to year. Bears fed on vegetation and on salmon along a tidal creek. Ratings of individual bears by observers on different aspects of behaviour, comparisons of behavioural frequencies, and long-term observations of individual activities served to assess personality differences. Individual bears varied in five ways: 1. Some bears were lively, animated and playful in social situations and during solitary activities such as travelling or fishing. Other bears' movements and general demeanour seemed dull and humourless; 2. Some bears were irascible, others socially uninvolved and unreactive; 3. Some bears were expert at fishing but others fished ineptly; 4. Some bears were confident with other bears but others lacked confidence in social situations; 5. Some bears were often active and alert. Others rested more frequently and for prolonged periods.

The authors studied behaviour of brown bears where they created activity budgets using behavioural observations in the wild. They used behaviours found from other papers in other species and from the behaviours that they observed in the bears during preliminary observations. The activity budgets presented by Fagen and Fagen (1996) were used to compare the activity budgets of this research and see if they can be compared with wild behaviour. However certain behaviours were not exhibited by the captive bears (i.e. fishing since there was no fish in the enclosure for the bears to hunt).

Our study is the first one describing ex situ Ursids personality. Captive animal studies provide information on the specific animals in the zoo in terms of their welfare, health and management as well as the exhibition of natural behaviours (Kleiman *et al.* 2010). Ideally, a captive population will exhibit the behaviour it would have in the wild (Melfi and Feistner 2002). In addition to the natural behaviour repertoire, captive animals might exhibit some unnatural behaviours, defined stereotypic behaviours. These include, among others pacing, head rolling, over grooming and self-directed behaviours and are considered to be caused by the stress caused by the artificial settings of the environment (Kleiman *et al.*, 2010). Bear species have been found to be exceptionally prone to stereotypical behaviours (Bauer *et al.* , 2013; Montaudouin and Le Pape, 2005; Veeraselvam *et al.*,2013) with sloth bears in particular being very susceptible to pacing (Montaudouin and Le Pape, 2005).

Simple observational studies can be used to create activity budgets to ascertain if wild and captive behaviours are similar and to observe any possible stereotypical behaviour that may affect the welfare of the animal (Anderson *et al.*, 2010).

Furthermore, a behavioural study can indicate the enclosure usage by the subject in order to identify if it is evenly used and properly structured (Plowman, 2003). Following Rose and Robert (2013) SPI results may suggest the necessity to substitute the unused area with biologically relevant ones to induce animals to use them.

In social animals, social interactions are considered to be an environmental enrichment, as they can improve the welfare of the animals, identify dominance and ranks in certain species as well as provide a better understanding of the dynamics of the population (Shepherdson *et al.*, 2012). In the case of solitary species, housing more than one individual can also be beneficial to the animals and, as Yoerg's (1999) experiments have shown, even though solitary species spent more time on their own, they still have social interactions with neighbouring individuals.

Eurasian brown bears and Sri Lankan sloth bears were used in this research study. Our primary focus was to draw, through behavioural observations, activity budgets and zone usage and outline social interactions, in order to assess welfare, health and management of the animals and secondly, to create personality profiles for each individual, using questionnaires and behavioural observations.

Although this study specifically focuses on Whipsnade zoo individual bears, this methodologies can also be used as guidelines to evaluate the welfare, management and conservation of the species in general. In addition, since there is extremely limited literature on bear personality, this study can be the starting point in producing an effective methodology for creating personality profiles in bears. This study is meant to encourage future further personality research, providing a reliable tool, accessible to anyone, to quickly assess zoo animals.

5.3 METHODS

Study Area and Animals

All the animals used were from ZSL Whipsnade Zoo in the United Kingdom. Two species of bears were used in this study: the Sri Lankan sloth bears, *Melursus ursinus inornatus* (two individuals) and the Eurasian brown bears, *Ursus arctos arctos*, (three individuals) (Table 5.1).

The sloth bears were kept in an enclosure (Figure 5.3) built as an outside paddock with access to small inside enclosures. Part of the outside enclosure was a dense forest area while the other was an open, grassy area with small hills and a large wooden structure the bears could climb on. Food was scattered or placed in enrichment object about every two hours on a fixed schedule and enrichment items were also placed in the enclosure every two to three days. The overall area of the enclosure was about 5695 m^2.

The brown bears had an enclosure (Figure 5.3) constituted mostly of an outside paddock with a small inside enclosure. the outdoor part display a dense forest with shrub vegetation. The enclosure also included a number of dens and a small shallow pool allowing drinking and bathing. The overall area of the enclosure is about 5503 m^2.

Table 5.1: Informations on study animals

Name	Species	Sex	Born	Born in	Relationship
Wendy	Brown Bear	Female	26/03/1991	Captivity	None
Wellington	Brown Bear	Female	15/01/1993	Captivity	Sister of Winslow
Winslow	Brown Bear	Female	15/01/1993	Captivity	Sister of Wellington
Ursula	Sloth Bear	Female	04/02/2001	Captivity	Daughter of Lanka
Colombo	Sloth Bear	Male	05/01/1998	Captivity	Son of Lanka

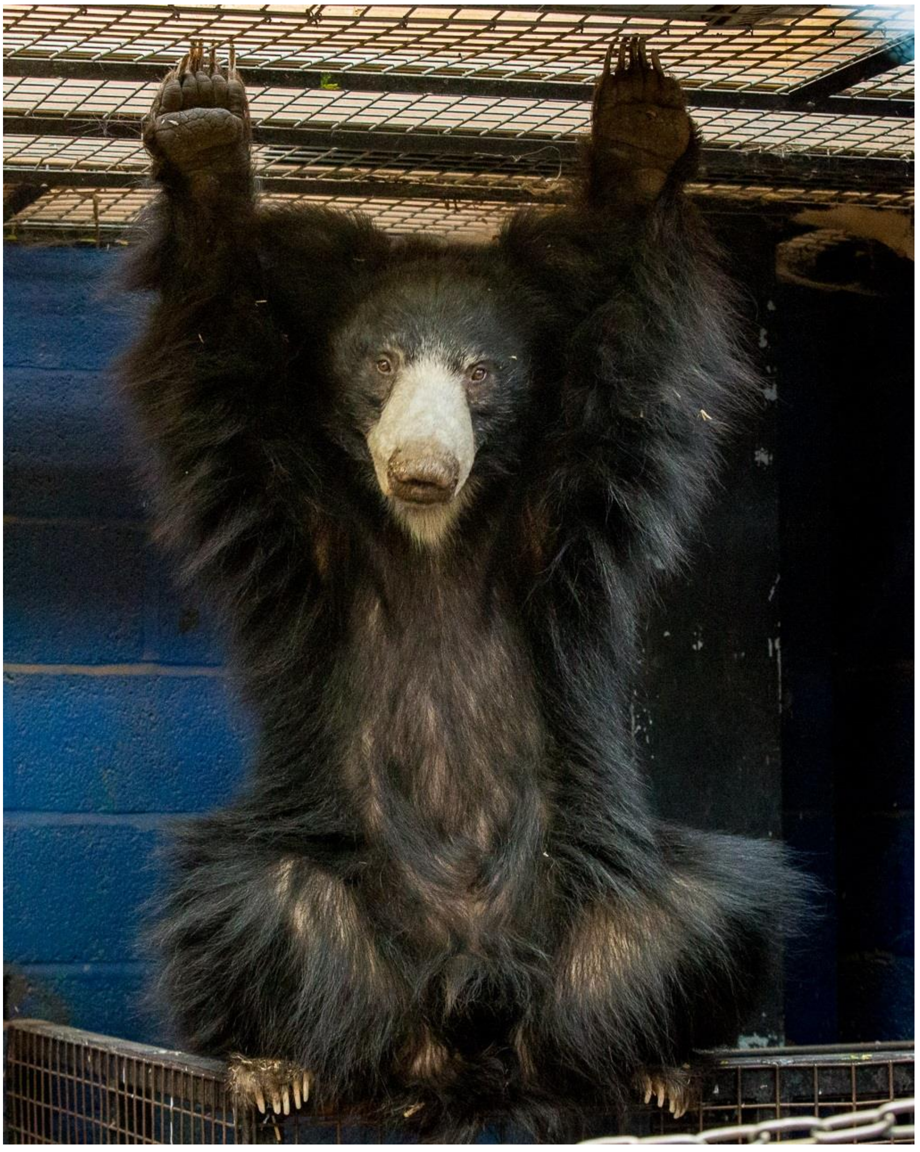


Figure 5.1: One of Whipsnade zoo sloth bears

Figure 5.2: Two of Whipsnade zoo brown bears

Observational Data

Bears were monitored three days a week for seven weeks, with four 50-minute sessions each day, two morning sessions (between 10:00-12:00) and two afternoon sessions (between 14:00-16:00). Lanka was kept in a separate paddock which required the observer to stand in another enclosure to observe her; this proved to be highly unpractical so we could not collect behavioural observations on her. The sessions alternated between the two species so that all the animals had equal time in each session slot. Focal sampling was used for this observation, choosing the sampling order randomly and state behaviour was recorded at 1 minute intervals (Martin and Bateson 2007). Event behaviours were recorded during the minute as they happened. During each session, time was split evenly on each animal, allowing 25 minutes for each sloth bear and 17 minutes for each brown bear.

Fig. 5.3: A brown bear enclosure and B sloth bear enclosure. The pictures show enclosure's division into zones, used for zone usage and the SPI.

The enclosures were divided into arbitrary sections (Figure 5.3) in order to observe the zone usage of each animal. In brown bears enclosure: section 1 was the inside enclosure and outside public view. Sections 2 and 3 were also outside public view for the most part and sections 4 and 5 were in public view. Section 5 had the pool and sections 4 and 1 were the ones used for most of the feeding. For the sloth bears enclosure: section 1 was he inside enclosure and section 5 was predominantly Lanka's enclosure. The other sections were mostly the same except for section 3 which had a wooden structure inside. Feeding took part in section 1 or in sections 2,3,4 evenly .This was used to calculate the Spread of Participation Index (SPI) for each individual (Plowman, 2003).

If an individual was within 7m of another individual during one of the observations, it was considered to be in close proximity. The close proximity total events was compared to the probability of a chance encounter (Chadwick, 2014).

Behaviour	Description
Inactive	Bear is lying, sitting, standing on four paws or upright on two paws whether on land or water. Lying can be on side, stomach or back.
Foraging and Eating	Bear is actively searching and consuming food. This includes digging to get to food. Distinction between foraging and eating is not made because handling time is minimal or absent in some cases.
Locomotion	Movement of the bear like walking on land and water, running or climbing trees or other structures.
Stereotypic	Behaviour not exhibited in the wild. Repetitive movement along the same path usually around 4 meters. 30 seconds was the time used to consider it pacing.
Aggression	Aggressive displays towards conspecifics or people.
Maintenance	Natural somatic behaviours like drinking water, urinating, defecating, grooming or scratching.
Affiliation	Positive/friendly behaviours towards conspecifics like playing, sniffing and rubbing.
Exploration	Interacting with the environment whether handling, sniffing or rubbing against objects or parts of the enclosure.
Vocal	Sounds emitted by the bears to show danger, alarm, anger or intimidation like barking and growling.

Table 5.2: Behavioural categories exhibited by the bears during observations.

An ethogram was created (Table 5.2) integrating observed behaviours with the data published in literature (Anderson *et al.* ,2010; Fagen and Fagen, 1996; MacHutchon ,2001; Ramesh *et al.*, 2013; Seryodkin *et al.*, 2013). Behaviours were grouped in categories (Veeraselvam *et al.*, 2013). Activity budgets for each individual were created using observational data.

Personality Profiles

Personality profiles were created using two methods, which both gave out a profile based on the NEO-FFI domains adapted for animals by Highfill and Kuczaj (2007). Conscientiousness was removed, as it is difficult to apply to non-primate animals (Gosling ,2001).

In the first method, called behavioural coding method, the behaviour of the animal is used to create a profile, based on the behavioural observations, that are grouped in appropriate domains (Table 5.3) using an adaptation of the procedure used by Birgersson (2011). Foraging and eating were used in two instances since it was considered to be both exploratory behaviour and a behaviour that shows activity.

Table 5.3: Each domain has a positive and a negative part and behaviours were assigned to each one. Some had no corresponding observed behaviours.

Openness to experience	**Extroversion**	**Agreeableness**	**Neuroticism**
+	+	+	+
Exploration	Vocal	Affiliation	Aggression
Foraging and eating	Locomotion		Stereotypic
	Foraging and eating		
-	-	-	-
	Inactive	Solitary	

The second method involved trait ratings, with information provided by the zoo keepers. Questionnaires were given to all the zoo keepers that have regular interactions with the bears, following the protocol from Chadwick (2014). In order to describe behavioural and personality aspect, the questionnaires included 22 adjectives, on a scale of 1-12. Three keepers filled the questionnaires for each animal. The mean ratings of the keepers were used to create the personality profiles by adding the adjectives to the appropriate domains (Table 5.4).

Table 5.4: Each domain has a positive and a negative part and adjectives were assigned to each one. Negative openness to experience was the only one with no corresponding adjectives

Openness to experience	**Extroversion**	**Agreeableness**	**Neuroticism**
+	+	+	+
Curious	Active	Friendly to conspecifics	Aggression to conspecifics
Smart	Playful	Friendly to keepers	Aggression to familiars
	Vocal	Friendly to familiars	Aggression to unfamiliars
	Excitable	Friendly to unfamiliars	Tense
			Eccentric
-	-	-	-
	Fear of conspecifics	Solitary	Calm
	Fear of familiars		Self Assured
	Fear of unfamiliars		
	Insecure		

Statistical Analysis and Presentation of Data

All of the statistical analysis and calculations were done using the programs Microsoft Excel 2007 and Minitab 16.

The SPI was used to see if the enclosure was used evenly by the animals or if there was skewed zone usage as described by Plowman (2003):

$$\mathrm{SPI} = \frac{\sum |f_o - f_e|}{2(N - f_{e\,min})}$$

where 'fo' is the observed frequency of observations in a specific zone and 'fe' is the expected frequency (calculated, following Plowman, 2003) with 'femin' being the expected frequency of the smallest area. N is the total number of observations.

In order to find the probability of a chance encounter, datasets of random points that represented random locations of the individuals were generated and the distance between two points was calculated (Chadwick, 2014). Any distance below 7m was considered to be a close proximity event. This was modified from the methodologies described by Chadwick, that used for cheetahs random points with no mass. In order to account for the dimensions of the bears, an extra 2m was added to the 5m described. The random chance value was then compared to the observational encounters using a Chi-squared test. The Kruskal-Wallis test was then used to estimate the significant difference between the domains of each animal and the post hoc Bonferroni test revealed which domains were significantly different from the others. Statistical analysis was done separately for both methods, since they produced two personality profiles. Inter-rater reliability of the trait ratings by the zoo keepers was tested using Kendall's coefficient of concordance since the raters were more than two. The behavioural groups used in the activity budgets were also statistically tested using the Kruskal-Wallis test with the Bonferroni post-hoc test to ascertain what activities the individuals performed more frequently.

5.4 RESULTS

Activity Budget

Activity budgets for each animal were created using the observational data (Table 5.5).

	Sloth Bears				Brown Bears					
Behaviours	Ursula		Colombo		Wendy		Wellington		Winslow	
	N	%	N	%	N	%	N	%	N	%
Out of sight	53	5	24	2	0	0	5	1	0	0
Inactive	348	31	281	25	415	57	355	49	323	44
Stereotypic	38	3	88	8	0	0	0	0	0	0
Foraging and Eating	400	36	505	45	181	25	184	26	194	27
Locomotion	223	20	160	14	119	16	169	24	197	27
Aggression	1	0	1	0	1	0	0	0	1	0
Maintenance	1	0	2	0	4	1	3	0	11	2
Vocal	0	0	1	0	1	0	0	0	2	0
Affiliation	8	1	5	0	2	0	1	0	1	0
Exploration	46	4	58	5	1	0	1	0	1	0
Total	1118	100	1125	100	724	100	718	100	730	100

Table 5.5: Activity budget table for each individual. N is the frequency of the behaviour in all of the observational time and % is the percentage of that behaviour from the total number of observed behaviours.

From this data, activity budget charts were created for each individual (Figure 5.4). In order to standardize the observation, the data were expressed in percentage. Significant variation in the activity budgets exists in all the individuals' behaviours, with H ranging from 204.53 to 254.70 ($p<0.05$).

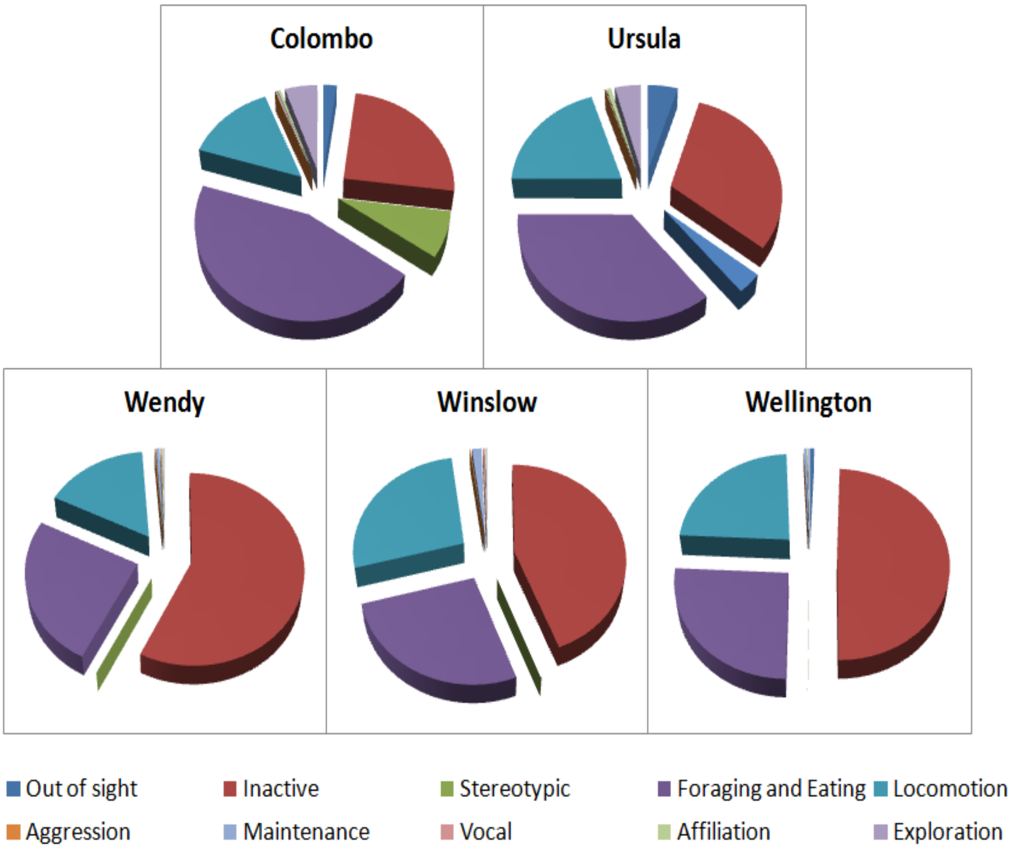


Fig. 5.4: Pie charts showing the activity budget of all individuals that were observed. Top are sloth bears and bottom are brown bears. Legend is read from left to right then top to bottom.

Both bear species spent most of their time foraging and eating, moving around the enclosure or being inactive. However, we can see from the table and the charts that brown bears spent almost half their time being inactive while the sloth bears spent approximately the same amount of time foraging and eating. In both bear species, behaviours like maintenance, aggression, affiliation or being vocal were observed at a very low frequency or none at all. These were all statistically verified with the Bonferroni post hoc test ($p<0.05$).

Zone Usage

The zone usage of each animal was noted during the observations and then used to calculate the SPI (Table 5.6).

		Zone 1		Zone 2		Zone 3		Zone 4		Zone 5		SPI	Mean SPI
	Animal	N	D	N	D	N	D	N	D	N	D		
Sloth	**Ursula**	327	309	366	72	176	-120	122	-97	59	-163	0.369	0.365
	Colombo	286	268	398	104	213	-83	133	-86	20	-201	0.360	
Brown	**Wendy**	97	37	64	-20	50	-107	347	150	156	-60	0.286	0.310
	Wellington	132	72	62	-22	45	-112	365	168	110	-106	0.367	
	Winslow	87	27	29	-55	30	-127	349	152	219	-3	0.278	

Table 5.6: Table showing zone usage for each individual and each zone. N is the observed frequency of the individual in that zone and D is the difference between the expected and the observed frequency. A negative value indicates less usage than expected and a positive value more usage than expected. SPI is the spread participation index with a scale of 0-1 with 0 being even usage and 1 being usage to one area.

SPI has a range of 0 to 1 where 0 means the individual is using the enclosure evenly and 1 that they use just one area of the enclosure, anything above 0 indicate a variable degree of unevenness. The difference between the expected and the observed usage, a by-product of the SPI calculation, is indicative of where there was higher or lower usage (Plowman, 2003).

The mean SPI for the sloth bears is 0.365 while the mean SPI for the brown bears is 0.310, showing that the usage of the zones was unequal. The difference between the observed and expected allows us to see which zones each individual used more and which less. The sloth bears used more zones 1 and 2 and zones 3, 4 and 5 less. The brown bears used zones 1 and 4 more and zone 2, 3 and 5 less.

Probability of Chance Encounter

For sloth bears, the expected value for close proximity chance encounters in the sampling period was 100 times, while the effective observed frequency of encounters was 892. This difference was found to be statistically significant (χ^2=6586.27, $p<0.05$), showing that sloth bears were found together more often than expected by chance. The brown bears' expected frequency was 306 while the observed frequency of encounters was 551, which again was statistically different (χ^2=228.85, $p<0.05$), showing that they were found together more than expected. For the brown bears Wellington and Winslow, we calculated with whom they spend more of their time in close proximity, Wendy who was unrelated or their sibling. Wellington spent more time with Winslow than Wendy (χ^2=20.455, $p<0.05$) and Winslow spent more time with Wellington than Wendy (χ^2=19.360, p<0.05).

Personality Profiles

Personality profiles are presented on one individual at a time. Each individual has a personality profile created using the observations and a profile created with the trait ratings. The domains, as mentioned in the introduction, will be used as O+,O-,E+,E-,A+,A-.N+,N-. Where specific domains are mentioned to be significantly different than others, it was always with a p<0.05.

Ursula

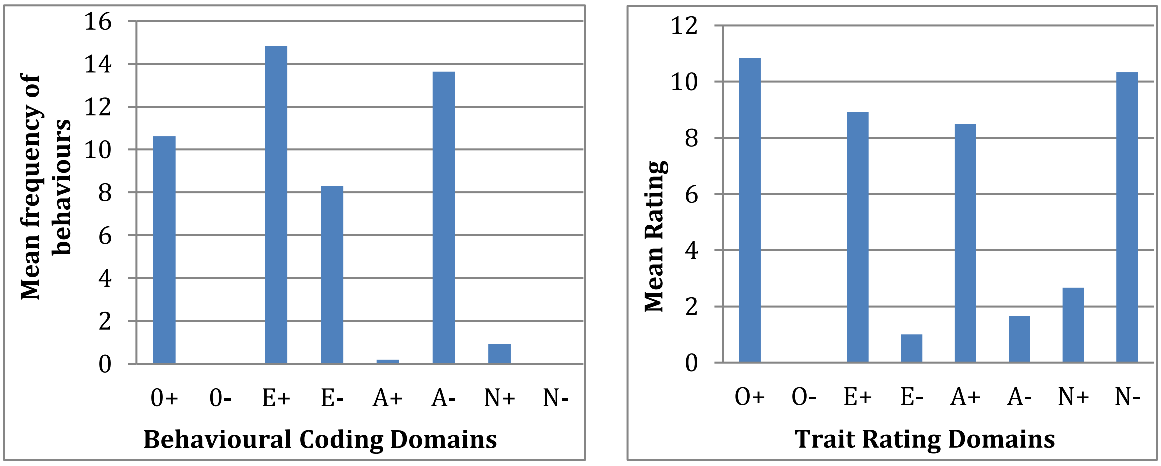


Fig. 5.5: Personality profiles showing the domains of Ursula. The left one was created using observations (behavioural coding) and the right one was created from the questionnaires (trait ratings).

Figure 5.3 shows the personality profiles of Ursula. In the behavioural coding profile, the domains were found to be statistically different (H=210.55, p<0.05) and the post hoc Bonferroni test showed that each of O+, E+, E-, A- are statistically different than each of O-, A+, N+ and N-. The trait rating profile again showed significant difference (H=22.14, p<0.05) and the post hoc Bonferroni test showed that the significantly different groups were O+ with O-, E- and there was a difference between N- with O-.

Colombo

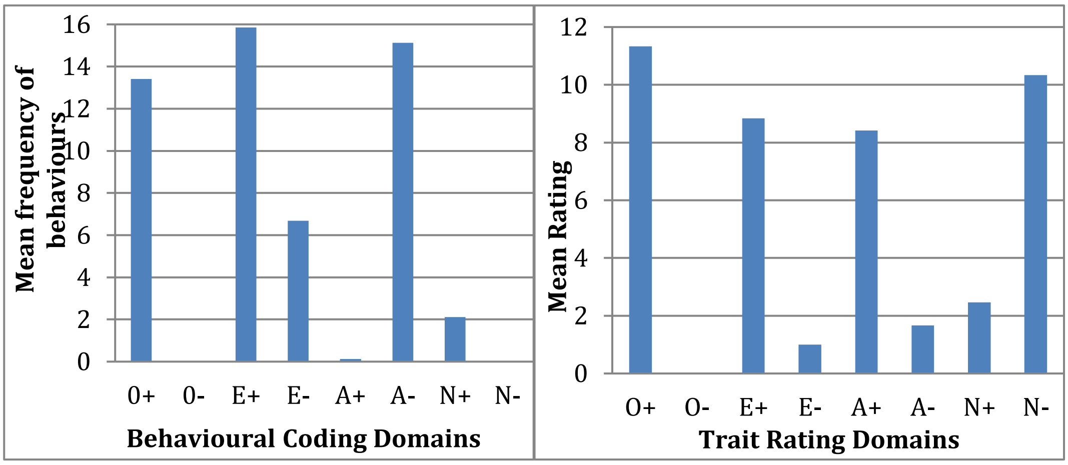


Fig. 5.6: Personality profiles showing the domains of Colombo. The left one was created by the observations (behavioural coding) and the right one was created from the questionnaires (trait ratings).

Figure 5.6 shows the personality profiles of Colombo. The behavioural coding profile showed statistical difference between the domains (H=208.27, $p<0.05$) with the post hoc Bonferroni test showing significant differences for O-, A+, N+ and N-, with each one being significantly different from each of O+, E+, E-, A-. E- was also significantly different to A- and E+. The trait ratings profile showed statistical difference (H=22.06, $p<0.05$) and post hoc Bonferroni showed statistical differences in O+ with O-,E- and difference between O- and N-.

Lanka

Lanka had no behavioural observations so she has only one profile created from the trait ratings (Figure 5.5). There was significant variation (H=20.14, $p<0.05$) and the groups that were significantly different were O- with N- and O+.

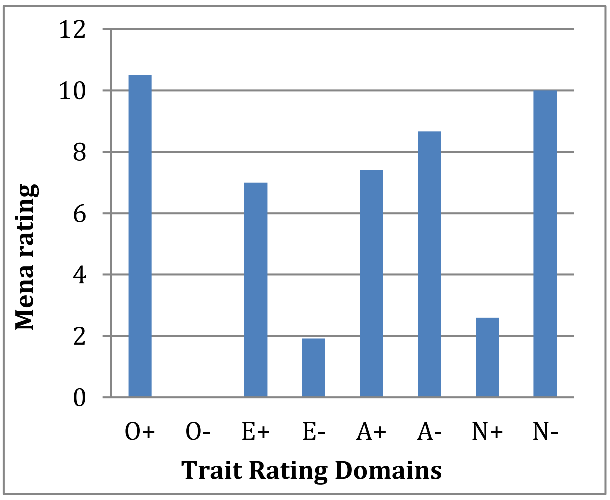


Figure 5.7: Personality profile showing the domains of Lanka. Created using trait ratings.

Wendy

Figure 5.8 shows the personality profiles created for Wendy. The behavioural coding profile showed statistical difference between domains (H=222.79, $p<0.05$) with A- being statistically different to all domains except E-, which is in turn statistically different from the rest, except E+. E+ and O+ are statistically different to the remaining domains. For the trait rating profiles there was statistical variation (H=39.99, $p<0.05$) with the group O- being different from N- ,O+,A+ and A-. O+ and N- are also statistically different from E- and N+.

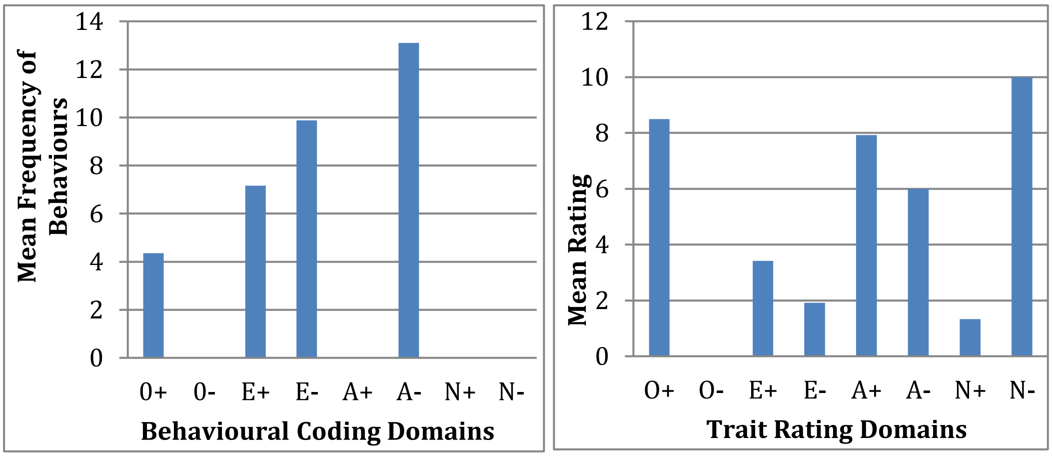


Fig. 5.8: Personality profiles showing the domains of Wendy. The left one was created by the observations (behavioural coding) and the right one was created from the questionnaires (trait ratings).

Wellington

Figure 5.9 shows the personality profiles of Wellington. The behavioural coding profile domains were found to be statistically different (H=261.30, $p<0.05$) and the post hoc Bonferroni test showed that O+, A-, E+, E - are statistically different from every other domain. Furthermore A- and O+ are statistically different from E+ and E-.The trait rating profile again showed significant difference (H=60.82, $p<0.05$) and the post hoc Bonferroni test showed that the significantly different groups were O+ and N- with O-,E-,N+. Also, there was significant difference between O- with A+,A-,E+ and in A+with N+ and E-.

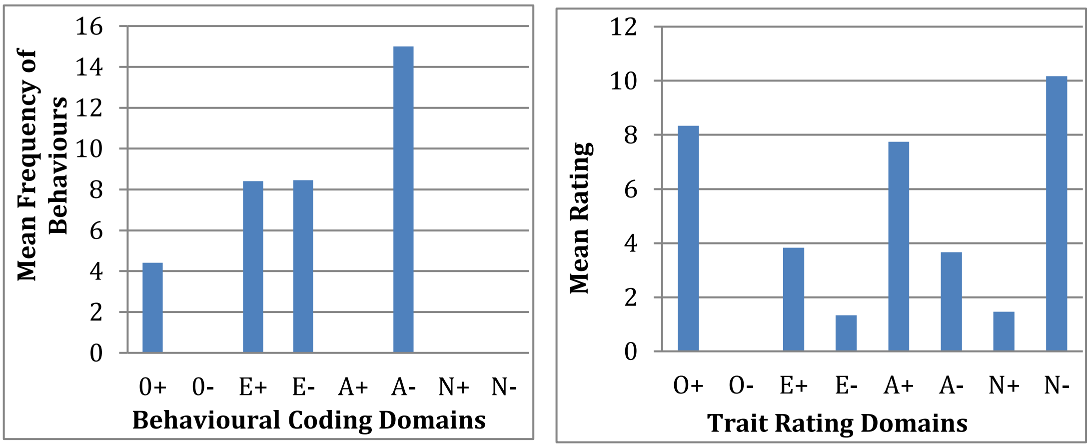


Fig. 5.9: Personality profiles showing the domains of Wellington. The left one was created by the observations (behavioural coding) and the right one was created from the questionnaires (trait ratings).

Winslow

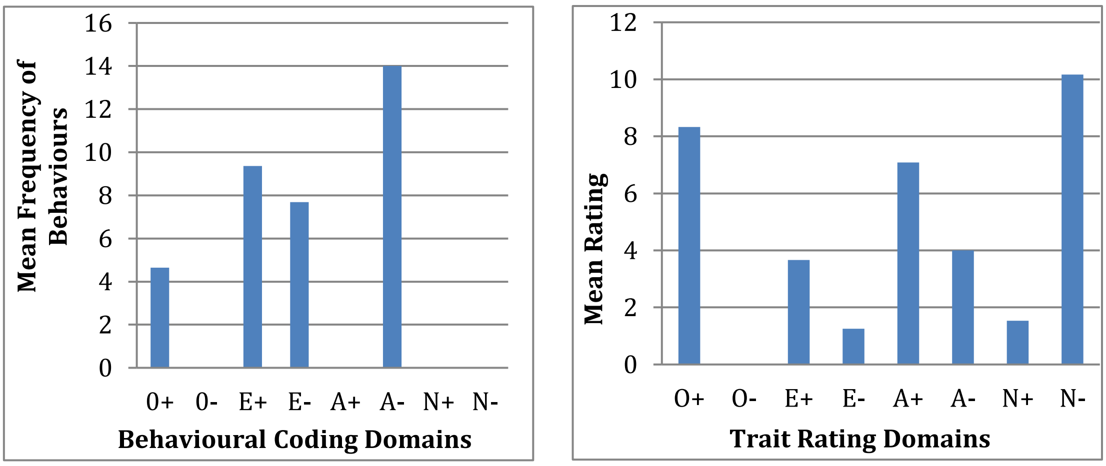


Fig. 5.10: Personality profiles showing the domains of Winslow. The left one was created by the observations (behavioural coding) and the right one was created from the questionnaires (trait ratings).

Figure 5.10 has the personality profiles of Winslow with the behavioural coding profile having statistical variation ($H=261.90, p<0.05$) with A-,E-,E+ and O+ being statistically different from O-A+,N+ and N-. A- is also statistically different from O+ and E- while E+ is different from O+.

Inter-rater reliability was statistically tested using Kendall's coefficient of concordance (W) for every trait. For the sloth bears mean W was 0.704 with only two traits being below 0.5. Standard deviation ranged from 0 to 3.06 for all the traits in all the sloth bears. In the same respect, the brown bears had a mean W of 0.771, with only two traits being below 0.5. Standard deviation ranged from 0 to 2 for all the traits in all the brown bears.

5.5 DISCUSSION

Activity Budget

The activity budgets (Table 5.5, Figure 5.4), created using the observational data, showed that both species of bears spent most of their time exhibiting behaviours that fall into the inactive, foraging and eating or locomotion categories. Brown bears spent almost half of their time being inactive while the other half is split between locomotion, foraging and eating. This is compatible with what other studies have showed on the activity budgets of brown bears, both in the wild and in captivity (Fagen and Fagen ,1996; MacHutchon, 2001; Montaudouin and Le Pape, 2005). Aggressive and affiliative behaviors were rarely observed. This could be due to the fact that all the brown bears are female thus having lower aggression displays (Fagen and Fagen, 1996) .As for affiliation, bears tend to be solitary animals so low affiliation observations are expected. (Fagen and Fagen ,1996; Montaudouin and Le Pape, 2005; Veeraselvam *et al.* ,2013).

A research from Montaudouin and Le Pape (2005) has shown that a large number of bears show stereotypic behaviour due to the small or unnatural enclosures or absence of landmarks like pools or ponds. In our study, brown bears, that live in a naturalistic enclosure, exhibit no stereotypic behaviours, like pacing or swaying, which is considered to be positive signs of their welfare (Le Pape ,2005).

Sloth bears spent more time foraging and eating than performing any other behaviour, with the rest of the time budget split between inactivity and locomotion. Furthermore, a small percentage of their activity was spent on other behaviours, like affiliation and exploration. This is consistent with behaviour observed in wild and desirable *ex situ* situations (Bauer *et al.,* 2013; Ramesh *et al.,* 2013).

The sloth bears exhibited stereotypic behaviour in the form of pacing, which accounted for 3 - 8% of their daily activity. Pacing can be exhibited in certain contexts by captive animals as a substitute behaviour, arising when they are not allowed to perform other natural behaviours, like foraging or hunting. This may also occur in situations when the individuals are fed without allowing them to forage (and allowing this could mitigate this undesirable behavior). In order to decrease such stereotypic behaviours, scatter feeding or other environmental enrichment techniques are suggested (Bauer *et al.,* 2013).

In Whipsnade zoo environmental enrichment administered to sloth bears is abundant, in form of scatter feeding occuring up to 10 times throughout the day, in order to keep them active and foraging. Moreover they also receive a number of enrichment items that are constantly changed on a regular basis.

Brown bears in this study, showing no apparent stereotypic behaviour, are fed at a specific location once or twice a day and have the large, densely forested natural enclosure with a pool as their only form of enrichment, Various forms of stereotypic behavior have been reported in several bear species (Montaudouin and Le Pape, 2005), sloth bears being notorious for their stereotypic exhibitions based on observed stereotypes (Bauer *et al.*, 2013).

The highest percentage of the pacing observed happened near the keeper facilities, which could be the reason behind the stereotypic behavior. Between bouts of pacing the sloth bears were “waiting” for the keepers to get the food out in the enclosure. Anticipatory behavior has been observed in other species as well when it was time to get the food out (Jensen *et al.*, 2013). So although anticipatory behavior is not considered stereotypic behavior it is possible that the two are related and anticipatory behaviour still decreases the welfare (Hansen and Jeppesen, 2006). Another explanation for the observed anticipatory behavior may be the diet of each animal: sloth bears rely almost completely on the food provided by their keepers, since they have not been observed eating grass or roots in their enclosure. On the other hand, brown bears eat roots and even graze at times so they can feed on the grass found in their enclosure, without having to wait for a keeper to bring them food resulting in less stereotypic behavior.

Zone usage

The use of SPI (Table 5.6) has helped to calculate how evenly the bears used their enclosure (Plowman, 2003). The mean SPI for each species was moderate (0.301 and 0.365) showing that the bears did not use their enclosure as evenly as possible. Taking into account the difference of expected and observed usage of each zone, it is evident that sloth bears were observed more in zones 1 and 2 whereas brown bears in zones 1 and 4. Rose and Robert (2013) state that animals seem to prefer certain areas over others based on their biological importance. This may explain the zone usage in this study. In both species zone 1 is where the indoor enclosure is located and also where they receive part of their feeding. The brown bears are also fed in zone 4, which also explains their preference for that zone. Regarding the sloth bears, zone 2 is where the keepers’ entrance is, so they spend a relevant portion of their time near that zone in order to see when the keepers come for their feeding. Since the SPI value is below the average, based on the aforementioned considerations we do not suggest a change in the enclosure design in order to improve the welfare of the animals (Rose and Robert, 2013).

Probability of chance encounter

Using the random generated points, we observed that ,both bear species, were found in close proximity significantly more that they were expected by random chance. We hypnotized that, being bears a solitary species, expected random chance of encounter would be low and that they would spend more time on their own than in close proximity with other individuals. A study by Perret and Predine (1984) measured cortisol levels in the solitary species of grey mouse lemurs, *Microcebus murinus* and showed that cortisol levels were higher when the individuals were housed socially. However, a certain social aspect is present in all animals including solitary animals given that each individual has adequate space for solidarity (Kleiman *et al.*, 2010).

In this case, the sloth bears are siblings, which causes them to associate more than they would if they were not related (Lodé, 2008). Two of the brown bears are siblings while the third one is not related to them. The bears have been living together all their life, since they were all born and raised together. This means that the unrelated brown bear is extremely familiarised with the others so this makes them feel comfortable being in close proximity (Lodé ,2008). However, the siblings spent significantly more time together than they did with Wendy, who is the unrelated bear.

Personality Profiles

Personality profile from behavioral coding described in literature are usually paired with tests like mazes for exploration, mirror tests or anti-predator behaviors. This tests require alterations to the environmental conditions of the animal, which are not always applicable or viable in zoos. These tests help identify specific personality characteristics, validating the profiles (Gosling, 2001). Hence, our study is aiming at creating a methodology, where behavioural observations can be used to infer personality traits. This approach minimizes animal disturbance and avoid invasive tests and has the advantage to be easily reproduced. Réale *et al*. (2007) argue that sampling normal behaviour to create personality profiles is subjective, since some behaviours are not easily classified into personality traits. However, conducting research on the matter can enable us finding which behaviours apply to each personality trait and thus, create valid personality profiles.

In certain animal groups like felids, research is more intensive (Chadwick, 2014; Phillips and Peck , 2007) which allow for behaviours to be more correctly applied to personality traits. Moreover, felids have more expressive behaviours, as they use different body stances, vocalisations as well as facial, ear or tail movements and positions to show their behaviour and feelings at the time, like vigilance, anger, fear, submission and affiliation (Kiley-Worthington, 1976; Stanton *et al.*, 2015) .

On the contrary, bears are not so expressive, and among females have less affiliative behaviour since they are solitary species (Fagen and Fagen, 1996; Montaudouin and Le Pape, 2005; Veeraselvam et al. 2013). The individuals observed in this study exhibited very low frequencies of affiliative, aggressive and vocal behaviour (Table 5). In addition, domains like N- and O- used for the personality profiles were not used in behavioural coding profiles (Figures 3-8) since there were no suitable behaviours for use in those domains.

Other domains like A+, A- and E- obtained from the behavioural coding profiles seem to be very different from the ones obtained by the trait rating profiles. This could be due to the fact that some behaviours were used for one domain instead of another and thus, in order to be able to distinguish which behaviour belongs where, more research has to be done. Moreover, domains like O+, E+ and N+ seem to be more consistent since they have similar impact in both profiles.

Using statistical tests like the Spearman's rank correlation, we can see how the domains created using trait ratings can be correlated with the domains using behavioural coding so as to merge the two at a later stage to get a more complete personality profile (Highfill *et al.*, 2010). However, this requires a much larger sample size than what we had in this study in order to get statistically significant results (Chadwick, 2014).

Furthermore, this current study on bears has a more reliable trait rating than the behavioural coding personality profile. That is, trait ratings have been used in a number of studies (Chadwick ,2014; Fagen and Fagen, 1996; Highfill and Kuczaj, 2007), which tested their reliability and validity. A study by Vazire *et al.* (2007) argued that trait ratings are more reliable indicators of personality if the raters are knowledgeable about their animals. Highfill *et al.* (2010) also agreed that trait ratings are more reliable as long as the relationship between the animal and the raters is the same (i.e. all keepers), as was applied in this study. Inter-rater reliability was statistically evaluated and found to be reliable for the majority of the trait adjectives (20). The ratings also had a maximum standard deviation of 3.06 for sloth bears and 2 for brown bears, showing that the keepers agreed on the animals' personality traits, which gave reliability to the results.

To conclude, in the current study the personality profiles were not created to be compared between individuals, but to form a viable methodology that could be applied to a number of bear species. A valid methodology can move personality research forward and use the new findings to the benefit of the animals. In turn, the information gathered from personality research will enable us to identify how different personalities react to new environments as well as new individuals with specific personality profiles. This will aid bear conservation efforts, in terms of reintroductions and captive breeding management and increase zoo animals health and welfare. Further study is needed to examine how different personality profiles interact with each other and to correlate the observed behaviours with the underlying personality traits, in order to predict individual behavioural responses to specific scenarios, knowing the personality of the individual. In conclusion, this study incorporates behavioural sampling with personality profiling to the benefit of Whipsnade zoo animals and aided in advancing personality research as a whole.

6. PERSONALITY AND SOCIALITY IN CAPTIVE ANIMALS: CATTLE

6.1 ABSTRACT

Knowledge of individual personality is a useful tool in animal husbandry and can be used effectively to improve welfare. This study assessed personality in five different breeds of dairy and beef cattle (*Bos taurus*) through a survey completed by handlers (milkers). The objective was to determine whether this method could detect differences in personality, including breed, age and sex differences. Milkers' assessments found breed and individual differences in dairy and beef cattle. Differences in personality traits resulted to be quite stark between individuals but consistent within each breed. This result shows how certain personality traits are more or less marked in cattle breeds that may differentiate themselves in terms of curiosity, friendliness to milkers, dominance and fear of unknown people. This pilot project shows the usefulness of personality questionnaires in cattle personality studies.

6.2 INTRODUCTION

The 1960' represented a "livestock revolution" in modern diary industry (MacKay, 2013) with production systems becoming intensive with larger farms housing more animals in increasingly more confined spaces (Fraser, 2008). Cattle were subject to dramatic physiological and behavioral changes in their social and physical environment. Animals respond to these stimuli in specie-specific and individual ways according to their individuality and personality (Gosling and John, 1999).

Scope of this project is to investigate how personality traits vary in a sample of 130 dairy cows and if it is possible to individuate breed-specific personality trends.

Do different breeds differentiate each other in terms of personality traits?

Personality in cattle

Within a herd of cows there will be variation in the behaviours displayed by individuals (Van Reenen, 2012). Not all cows will display the same aspects of the species' behavioural repertoire to the same degree. This often happens in clusters of similar behaviours. For example, all cows must compete at a feeding area but not all cows will show the same levels of aggression to other cow. Some will be consistently less aggressive and others more aggressive (Gibbons *et al.*, 2009b). Cattle have the capacity to show fear in response to an unexpected stimuli (Forkman *et al.*, 2007).

However the levels of fear displayed by individuals towards the same stimuli will vary and again this variation is consistent within the individual (Gibbons *et al.*, 2009a).

Based on these considerations MacKay (2013) speaks of 'aggression' and 'fearfulness' as being personality traits in cattle.

In studying personality traits in animal species, many ethologists have found five main domains similar to the human Five Factor Model (FFM) of personality (Gosling & John ,1999). The five domains in the FFM are commonly referred to as neuroticism (featuring anxiety, depression, a

vulnerability to stress and moodiness), agreeableness (featuring trust, cooperation and a lack of aggression), extraversion (featuring sociableness, assertiveness, activity and general positive emotions), openness (featuring intellect, imagination, creativity and curiosity) and conscientiousness (featuring deliberation, self-discipline, dutifulness and order) (Gosling & John, 1999). There is some debate as to whether the FFM is appropriate to use in animal species (Uher, 2008) or even within all human cultures (Gurven *et al.*, 2012) as many of these labels encompass traits that we might consider to be exclusively human orientated. Gosling and John (1999) found that extraversion, neuroticism and agreeableness were all observed in a range of animal species from primate, non-primate mammals, octopus and fish. They also found evidence of openness in several species and the possibility of two extra dimensions in animal species, activity and dominance. However, the difficulty in interpreting these labels means that these words are often not used to describe the traits in the studies where they are found (Gosling & John, 1999).

Within cattle, there is no stated consensus as to how many personality traits may exist. The research tends to focus on those traits which have a clear relationship with welfare, such as fearfulness and sociableness, which may be related to the FFM domains of neuroticism, agreeableness and extraversion.

6.3 MATERIALS AND METHODS

Dairy Farms

The animals selected for the study will be part of three different dairy farms where the management and feeding condition are similar, all farms adopt the tie-stall housing system.

The first farm is located in the mountain (1050 m a.s.l.) where the cows are fed with hay of permanent meadows (meadows of more than 200 years made and consisting of spontaneous essences, grown without, grown without chemical fertilizers and weed control). The herd is composed by 20 animals belonging only to the Varzese breed and the milk produced is used entirely within the farm for the cheesemaking process.

The second farm is located in the in lowland, where the cows are fed with hay of semi-permanent meadows (alpha-alpha, sorghum and gramineae) with a low energy and protein integration with corn meal and soybeans meal. This farm has a mixed herd composed by 35 animals belonging to Holsetein, Brown Swiss and Italian Red Pied breeds.

The third farm is located in Valle Salimbene, near Pavia (North Italy). Until the 80s this was a typical Lombardy farm, with 100 Holstein in milking but in the 90s the owner decided to focus on Italian endangered native breeds. He started buying 2 old (15 years) cows of Varzese breed, the unique autochthonous Lombardy's breed, and today after 30 years his farm is one of the greatest example of farm animals biodiversity. Today in the farm we can find a herd composed by about 200 animals, are present 15 of the 19 Italian cattle native breeds, and also many sheep and gomats Italian native breeds. Chierico have also recovered a traditional type of feeding for his cows, based on the reduction of the concentrates intake in favor of the forages.

Fig.6.1. Dairy cattle breeds surveyed in this research ; from top left :Bruna, Modenese, Frisona (Holstein Frisian), Rendena and Varzese

Cattle breeds

Bianca Val Padana

The Bianca Val Padana cattle are also known as "Modenese cattle". Its name derived from the area of distribution in the provinces of Modena, Reggio Emilia, Mantova, Ferrara, Bologna. In 1960 there were about 142.000 heads, at present their number has greatly decreased because of the highly competitive diffusion of cosmopolitan breeds. Today approximately 650 cows of Modenese breed exist, many of these reared in herds together with cosmopolitan breeds (Curone *et al.*, 2016; Duclos and Hiemstra, 2010; Petrera *et al.*, 2014). According to breed standards, adult female Bianca Val Padana cows are 125-140 centimeters in height with an average body weight of 650 kilograms. Adult male bulls are 130-160 centimeters in height with an average body weight of 980 kilograms. Males have white coats with grey areas on their necks, shoulders, and hips while the females have all white coats. The typical characteristic of this Italian breed is the so-called 'cut', that is a pink colored reversed V in the centre of the dark grey wide muzzle. The Bianca Val Padana is double-purpose breed, is used for both milk and meat production.

Rendena

The area of origin of this breed is Rendena Valley (Trentino). Today, this breed is spread in many provinces of the northern Italy, especially in Padua, Trento, Vicenza, Verona. It's a medium-small breed, is particularly adapts to pastures, withers height of 130 cm for females and 135 cm for males with a maximum adult weight of 5.5 quintals (Varotto *et al.*, 2015). The mantle has differing in gradation in females and darker, almost black, in males. Its hair is smooth, with a lighter, reddish stroke and lumbar stripe; its other peculiar characteristics are the ivory tufts inside the ears, the black, white-haloed muzzle and the forelock on the top of its head. The horns are light and white, with black tips. It is a rustic and energetic double-purpose animal, mainly used for milk production

Varzese

The Varzese is the unique autochthonous breed from Lombardia. Its origin is in the Apennines located in five regions (belonging to the ancient low Lombardy): Lombardia, Emilia, Toscana, Liguria and Piemonte (Cummond *et al.*, 2010). It is likely that Varzese breed reached Italy following the barbarians during the sixth century. Actually it is known that Longobards had brought dark golden red coated cattle into the Po Valley in the sixth century. The cows belonging to this breed show a uniform reddish-blond coat, more or less intense, with limited lighter shades around their muzzles, eyes, bellies, inner thighs and distal limbs (Cummond *et al.*, 2011) . Their medium size (withers height of 135 cm for females and 145 cm for males with a maximum adult weight of 5.5 quintals), and their characteristics of rusticity, frugality, fertility and longevity make these animals the first choice in marginal areas like mountain, wood and foothill grazes.

Holstein Frisian

The Holstein breed originated in Europe, in particular in two Dutch provinces the North Holland and Friesland. Holsteins are large cattle with color patterns of black and white or red and white. A mature Holstein cow weighs around 650-750 kilograms and stand 130-150 centimeters tall at the shoulder. The Adult male bulls are 138 - 155 centimeters in height with an average body weight of 900 - 1300 kilograms. Holsteins have the highest milk productions in the world, the average production of the Italian Holstein-Friesian Cows in 2015 was 9.325 ± 2.158 kilograms of milk with 3,67 ± 0,53 % of fat and 3,25 ± 0,32 % of protein (Italian breeder association, 2015). Holstein heifers can be bred at 15-16 months of age, when they weigh about 360 kilograms. While some cows may live considerably longer, the normal productive life of a Holstein is six years with a mean of 2,49 lactations (Italian breeder association, 2015). More than 22 million animals are registered in the Holstein Association's herdbook.

Brown

The Brown Swiss bred in Italy is the Italian strain of the Brown Swiss breed, derived from the introduction of Swiss, Austrian and partly Bavarian animals adapted to our environment and, especially in recent years, with the addiction of blood of the American Brown Swiss strain. Today the Brown Swiss is the second largest dairy breed in the world with a reported over 8 million registered cattle and the world population estimated at over 14 million head. The Brown Swiss is light brown in color with a creamy white muzzle and dark nose. The Adult male bulls are 140-150centimeters in height with an average body weight of 750-900 kilograms. The Brown Swiss cow weighs around 500-600 kilograms and stand 130-140 centimeters tall at the shoulder. Brown Swiss are robust, a prolific breeder, long-lived, strong, adaptable, and very well-balanced in build with good hooves and limbs. The average production of the Brown Swiss cows in 2015 was 7.095 ± 1.933 kilograms of milk with 4,00 ± 0,48 % of fat and 3,52 ± 0,35 % of protein.

Personality questionnaire

Milkers in the three dairy farms were asked to fill a personality questionnaire evaluating each of the resident cows. The questionnaire is a modified version of the one developed by Chadwick (2014). After a few questions addressed to the milker to assess how long he/she has worked with these cows and how often he/she has contact with them, the questionnaire articulates in 31 different questions. Each question focus on an adjective used to describe a different aspect of the animal's personality (e.g. "friendly to conspecifics", see table one for the adjectives' list and the abbreviation used) and the rater (the milker) can assign a scale from one to twelve to define the intensity of this personality trait (e.g. from one "never friendly to conspecifics", to six "sometimes friendly to conspecifics" to twelve "always friendly to conspecifics"). We propose Chadwick's questionnaire as a standardized and flexible tool to assess animal personality in different taxa. An example of the questionnaire (adapted to Asiatic lions) can be found in Appendix 3. Since only one milker was present in each farm ,and the cows are always kept together, questions like "friendly to you", "aggressive to you", "fearful of you" and "solitary"were deleted from the questionnaire rounding down the adjectives to a total of 26.

Adjective	**Variable**
Active	Active
Aggressive versus conspecifics	Agvcon
Aggressive versus known people	Agvkn
Aggressive versus unknown people	Agvunk
Aggressive versus keepers (milker)	Agvkeeper
Calm	Calm
Cooperative	Coop
Curious	Curious
Excitable	Excit
Friendly versus conspecifics	Frvcon
Friendly versus keepers (milker)	Frvkeeper
Friendly versus known people	Frvkn
Friendly versus unknown people	Frvunk
Dominant	Dominant
Fearful of conspecifics	Fearcon
Fearful of known people	Fearkn
Fearful of unknown people	Fearunk
Fearful of keepers (milker)	Fearkeeper
Insecure	Insecure
Playful	Playful
Self-assured	Selfass
Smart	Smart
Tense	Tense
Shy	Shy
Vocal: aggressive	Vocaggr
Vocal: non-aggressive	Vocanonagg

Table 6.1. Questionnaire's adjectives/ traits and corresponding abbreviations/variables

Statistical analysis

The considered variables were analyzed by a descriptive statistics: for each variable, the minimum value, the maximum value, the range, the first, the third quartile, the median value, the mean and the standard deviation were calculated

6.4 RESULTS

The univariate overall descriptive statistics is reported in table 6.2. All the variables cover the whole range 1-12, except for “playful”, “tense” and “vocanonaggr”. Due to the nature of data (score without a normal distribution), the median values were considered as central tendence values.

Variable	n	Min	Max	Range	1st	Median	3rd	Mean	Stddev
active	40	1.000	12.000	11.000	2.000	5.000	8.000	5.125	3.406
agvcon	40	1.000	12.000	11.000	1.000	3.000	6.250	3.875	3.057
agvkn	40	1.000	12.000	11.000	1.000	1.000	2.000	2.625	3.061
agvunk	40	1.000	12.000	11.000	1.000	2.000	7.000	3.800	3.421
agvkeeper	40	1.000	12.000	11.000	1.000	1.000	2.000	2.225	2.713
calm	40	1.000	12.000	11.000	4.500	9.000	11.250	7.728	4.283
coop	40	1.000	12.000	11.000	7.000	9.000	12.000	9.275	2.855
curious	40	1.000	12.000	11.000	6.000	7.000	8.250	6.600	3.334
excit	40	1.000	12.000	11.000	1.000	2.000	7.000	3.775	3.438
frvcon	40	1.000	12.000	11.000	7.000	7.000	10.000	7.200	3.353
frvkeeper	40	1.000	12.000	11.000	6.750	7.000	11.250	8.075	3.576
frvkn	40	1.000	12.000	11.000	2.750	7.000	8.000	6.050	3.728
frvunk	40	1.000	12.000	11.000	1.000	2.000	3.750	3.125	3.006
dominant	40	1.000	12.000	11.000	1.000	2.500	6.000	3.900	3.629
fearcon	40	1.000	12.000	11.000	1.000	3.000	7.000	4.225	3.270
fearkn	40	1.000	12.000	11.000	1.000	2.000	7.000	4.075	3.526
fearunk	40	1.000	12.000	11.000	4.250	7.000	10.000	7.000	3.755
fearkeeper	40	1.000	12.000	11.000	1.000	2.000	3.000	2.575	2.872
insecure	40	1.000	12.000	11.000	1.750	4.000	7.000	4.800	3.436
playful	40	1.000	7.000	6.000	1.000	3.000	5.000	3.325	2.314
selfass	40	1.000	12.000	11.000	1.000	7.000	10.000	6.200	4.274
smart	40	1.000	12.000	11.000	5.000	7.000	11.000	7.225	3.971
tense	40	1.000	10.000	9.000	1.000	1.000	3.000	2.275	2.287
shy	40	1.000	12.000	11.000	2.750	5.000	7.000	5.575	3.782
vocaggr	40	1.000	12.000	11.000	1.000	1.000	2.033	1.823	1.954
vocanonagg	40	1.000	10.000	9.000	1.000	2.000	2.423	2.565	2.199

Table 6.2. Univariate overall descriptive statistic results

In order to evaluate differences between breeds, every breed was analyzed for the aforementioned variables, and the differences between breeds were calculated by the Kruskal-Wallis nonparametric test, calculating the differences between median values. The statistical significance was set at $p<0.05$.

The descriptive statistics for each breed is reported in table 6.3.

Sample	N	Min	Max	Range	1st	Median	3rd	Mean	Stddev
active | bruna	8	1.000	3.000	2.000	1.000	2.000	3.000	2.000	1.069
active | frisona	9	3.000	8.000	5.000	4.000	6.000	7.000	5.556	1.810
active | modenese	8	1.000	12.000	11.000	2.000	4.500	8.250	5.625	4.565
active | rendena	6	1.000	8.000	7.000	1.000	1.000	5.500	3.167	3.371
active | varzese	9	6.000	10.000	4.000	8.000	9.000	9.000	8.333	1.500
agvcon | bruna	8	1.000	3.000	2.000	1.000	1.500	2.250	1.750	0.886
agvcon | frisona	9	1.000	8.000	7.000	3.000	4.000	4.000	3.889	1.900
agvcon | modenese	8	1.000	6.000	5.000	2.000	2.000	2.000	2.375	1.506
agvcon | rendena	6	1.000	12.000	11.000	1.000	1.000	6.250	4.000	4.817
agvcon | varzese	9	1.000	10.000	9.000	7.000	7.000	8.000	7.000	2.646
agvkn | bruna	8	1.000	1.000	0.000	1.000	1.000	1.000	1.000	0.000
agvkn | frisona	9	1.000	8.000	7.000	1.000	1.000	5.000	3.111	3.060
agvkn | modenese	8	1.000	12.000	11.000	1.000	1.000	2.500	3.125	4.155
agvkn | rendena	6	1.000	12.000	11.000	1.000	1.000	1.000	2.833	4.491
agvkn | varzese	9	1.000	6.000	5.000	1.000	2.000	6.000	3.000	2.291
agvunk | bruna	8	1.000	2.000	1.000	1.000	1.000	2.000	1.375	0.518
agvunk | frisona	9	1.000	4.000	3.000	1.000	2.000	3.000	2.000	1.118
agvunk | modenese	8	1.000	12.000	11.000	1.000	1.000	2.500	3.125	4.155
agvunk | rendena	6	7.000	12.000	5.000	7.000	7.000	7.000	7.833	2.041
agvunk | varzese	9	1.000	11.000	10.000	3.000	6.000	7.000	5.667	3.428
agvkeeper | bruna	8	1.000	1.000	0.000	1.000	1.000	1.000	1.000	0.000
agvkeeper | frisona	9	1.000	6.000	5.000	1.000	2.000	3.000	2.444	1.878
agvkeeper | modenese	8	1.000	12.000	11.000	1.000	1.000	2.500	3.125	4.155
agvkeeper | rendena	6	1.000	12.000	11.000	1.000	1.000	1.000	2.833	4.491
agvkeeper | varzese	9	1.000	5.000	4.000	1.000	1.000	2.000	1.889	1.364
calm | bruna	8	1.000	11.000	10.000	1.000	5.000	10.000	5.500	4.840
calm | frisona	9	1.000	12.000	11.000	7.710	7.710	9.000	7.237	3.792
calm | modenese	8	12.000	12.000	0.000	12.000	12.000	12.000	12.000	0.000
calm | rendena	6	1.000	11.000	10.000	11.000	11.000	11.000	9.333	4.082
calm | varzese	9	1.000	12.000	11.000	3.000	5.000	7.000	5.333	3.500
coop | bruna	8	8.000	12.000	4.000	9.000	10.500	12.000	10.375	1.768
coop | frisona	9	7.000	12.000	5.000	9.000	9.000	10.000	9.556	1.667
coop | modenese	8	7.000	12.000	5.000	10.750	12.000	12.000	10.750	2.315
coop | rendena	6	1.000	12.000	11.000	7.000	9.500	12.000	8.500	4.416
coop | varzese	9	1.000	12.000	11.000	7.000	7.000	7.000	7.222	2.949
curious | bruna	8	6.000	7.000	1.000	6.750	7.000	7.000	6.750	0.463
curious | frisona	9	6.000	11.000	5.000	6.000	7.000	10.000	7.667	2.062
curious | modenese	8	1.000	1.000	0.000	1.000	1.000	1.000	1.000	0.000
curious | rendena	6	7.000	12.000	5.000	7.000	7.000	7.000	7.833	2.041
curious | varzese	9	7.000	12.000	5.000	8.000	10.000	11.000	9.556	1.878
excit | bruna	8	1.000	3.000	2.000	1.000	1.500	2.000	1.625	0.744
excit | frisona	9	1.000	7.000	6.000	2.000	2.000	6.000	3.556	2.404
excit | modenese	8	1.000	12.000	11.000	1.000	1.000	2.500	3.125	4.155
excit | rendena	6	1.000	12.000	11.000	2.500	7.000	7.000	5.833	4.215
excit | varzese	9	1.000	11.000	10.000	2.000	5.000	7.000	5.111	3.855
frvcon | bruna	8	7.000	10.000	3.000	7.000	8.500	10.000	8.500	1.604

frvcon | frisona	9	1.000	11.000	10.000	8.000	9.000	10.000	8.222	3.073
frvcon | modenese	8	1.000	7.000	6.000	5.500	7.000	7.000	5.500	2.777
frvcon | rendena	6	1.000	12.000	11.000	1.000	4.000	10.750	5.667	5.428
frvcon | varzese	9	1.000	11.000	10.000	7.000	7.000	11.000	7.556	3.206
frvkeeper | bruna	8	10.000	12.000	2.000	10.750	11.500	12.000	11.250	0.886
frvkeeper | frisona	9	5.000	12.000	7.000	5.000	7.000	10.000	7.778	2.949
frvkeeper | modenese	8	1.000	12.000	11.000	5.500	7.000	7.000	6.125	3.603
frvkeeper | rendena	6	1.000	12.000	11.000	7.000	7.000	7.000	6.833	3.488
frvkeeper | varzese	9	1.000	12.000	11.000	6.000	10.000	12.000	8.111	4.343
frvkn | bruna	8	7.000	12.000	5.000	7.000	9.500	12.000	9.500	2.673
frvkn | frisona	9	3.000	7.000	4.000	3.000	6.000	6.000	5.000	1.732
frvkn | modenese	8	1.000	12.000	11.000	5.500	7.000	7.000	6.125	3.603
frvkn | rendena	6	1.000	1.000	0.000	1.000	1.000	1.000	1.000	0.000
frvkn | varzese	9	1.000	11.000	10.000	7.000	8.000	10.000	7.333	3.606
frvunk | bruna	8	1.000	3.000	2.000	1.000	1.500	3.000	1.875	0.991
frvunk | frisona	9	1.000	6.000	5.000	1.000	2.000	2.000	2.222	1.563
frvunk | modenese	8	1.000	7.000	6.000	5.500	7.000	7.000	5.500	2.777
frvunk | rendena	6	1.000	1.000	0.000	1.000	1.000	1.000	1.000	0.000
frvunk | varzese	9	1.000	12.000	11.000	2.000	2.000	6.000	4.444	4.531
dominant | bruna	8	1.000	4.000	3.000	1.000	1.000	3.000	1.875	1.246
dominant | frisona	9	1.000	11.000	10.000	3.000	4.000	5.000	4.333	3.041
dominant | modenese	8	1.000	12.000	11.000	1.000	1.000	3.750	3.750	5.092
dominant | rendena	6	1.000	12.000	11.000	7.000	7.000	7.000	6.833	3.488
dominant | varzese	9	1.000	11.000	10.000	1.000	2.000	6.000	3.444	3.504
fearcon | bruna	8	1.000	5.000	4.000	1.000	1.500	3.250	2.250	1.581
fearcon | frisona	9	1.000	6.000	5.000	2.000	3.000	4.000	3.111	1.616
fearcon | modenese	8	1.000	12.000	11.000	7.000	7.000	8.250	7.500	3.464
fearcon | rendena	6	1.000	12.000	11.000	7.000	7.000	7.000	6.833	3.488
fearcon | varzese	9	1.000	6.000	5.000	1.000	1.000	3.000	2.444	2.128
fearkn | bruna	8	1.000	2.000	1.000	1.000	1.500	2.000	1.500	0.535
fearkn | frisona	9	1.000	9.000	8.000	1.000	2.000	8.000	4.111	3.551
fearkn | modenese	8	1.000	12.000	11.000	7.000	7.000	8.250	7.500	3.464
fearkn | rendena	6	1.000	12.000	11.000	1.000	4.000	7.000	4.833	4.579
fearkn | varzese	9	1.000	6.000	5.000	1.000	2.000	4.000	2.778	1.856
fearunk | bruna	8	2.000	7.000	5.000	2.000	4.500	7.000	4.500	2.673
fearunk | frisona	9	1.000	12.000	11.000	2.000	5.000	7.000	4.889	3.551
fearunk | modenese	8	7.000	12.000	5.000	7.000	7.000	8.250	8.250	2.315
fearunk | rendena	6	12.000	12.000	0.000	12.000	12.000	12.000	12.000	0.000
fearunk | varzese	9	1.000	10.000	9.000	6.000	7.000	10.000	6.889	3.689
fearkeeper | bruna	8	1.000	3.000	2.000	1.000	2.000	3.000	2.000	1.069
fearkeeper | frisona	9	1.000	5.000	4.000	2.000	2.000	3.000	2.556	1.130
fearkeeper | modenese	8	1.000	12.000	11.000	1.000	1.000	3.750	3.750	5.092
fearkeeper | rendena	6	1.000	12.000	11.000	1.000	1.000	1.000	2.833	4.491
fearkeeper | varzese	9	1.000	3.000	2.000	2.000	2.000	2.000	1.889	0.601
insecure | bruna	8	1.000	5.000	4.000	1.000	1.000	3.000	2.000	1.512
insecure | frisona	9	2.000	7.000	5.000	3.000	4.000	5.000	3.889	1.616
insecure | modenese	8	1.000	12.000	11.000	1.000	4.000	8.250	5.250	4.921
insecure | rendena	6	7.000	12.000	5.000	7.000	7.000	7.000	7.833	2.041
insecure | varzese	9	1.000	11.000	10.000	3.000	7.000	7.000	5.778	3.492
playful | bruna	8	3.000	7.000	4.000	3.750	5.500	7.000	5.250	1.909
playful | frisona	9	1.000	5.000	4.000	3.000	4.000	4.000	3.444	1.333
playful | modenese	8	1.000	1.000	0.000	1.000	1.000	1.000	1.000	0.000
playful | rendena	6	1.000	1.000	0.000	1.000	1.000	1.000	1.000	0.000
playful | varzese	9	2.000	7.000	5.000	3.000	6.000	7.000	5.111	2.088

selfass | bruna	8	8.000	12.000	4.000	9.000	10.500	12.000	10.375	1.768
selfass | frisona	9	3.000	10.000	7.000	7.000	8.000	9.000	7.667	2.236
selfass | modenese	8	1.000	1.000	0.000	1.000	1.000	1.000	1.000	0.000
selfass | rendena	6	1.000	1.000	0.000	1.000	1.000	1.000	1.000	0.000
selfass | varzese	9	7.000	12.000	5.000	7.000	10.000	10.000	9.111	2.147
smart | bruna	8	10.000	12.000	2.000	10.000	11.000	12.000	11.000	1.069
smart | frisona	9	4.000	11.000	7.000	6.000	7.000	10.000	7.778	2.728
smart | modenese	8	1.000	11.000	10.000	1.000	1.000	1.000	2.250	3.536
smart | rendena	6	1.000	7.000	6.000	7.000	7.000	7.000	6.000	2.449
smart | varzese	9	5.000	12.000	7.000	5.000	7.000	12.000	8.556	3.358
tense | bruna	8	1.000	3.000	2.000	1.000	2.000	3.000	2.000	1.069
tense | frisona	9	2.000	7.000	5.000	2.000	2.000	3.000	2.889	1.616
tense | modenese	8	1.000	1.000	0.000	1.000	1.000	1.000	1.000	0.000
tense | rendena	6	1.000	1.000	0.000	1.000	1.000	1.000	1.000	0.000
tense | varzese	9	1.000	10.000	9.000	1.000	2.000	7.000	3.889	3.951
shy | bruna	8	1.000	3.000	2.000	1.000	2.000	3.000	2.000	1.069
shy | frisona	9	1.000	9.000	8.000	3.000	5.000	5.000	4.222	2.333
shy | modenese	8	7.000	7.000	0.000	7.000	7.000	7.000	7.000	0.000
shy | rendena	6	12.000	12.000	0.000	12.000	12.000	12.000	12.000	0.000
shy | varzese	9	1.000	10.000	9.000	1.000	5.000	6.000	4.556	3.779
vocaggr | bruna	8	1.000	2.130	1.130	1.000	1.565	2.130	1.565	0.604
vocaggr | frisona	9	2.000	3.000	1.000	2.000	2.000	2.130	2.154	0.323
vocaggr | modenese	8	1.000	1.000	0.000	1.000	1.000	1.000	1.000	0.000
vocaggr | rendena	6	1.000	7.000	6.000	1.000	1.000	1.000	2.000	2.449
vocaggr | varzese	9	1.000	12.000	11.000	1.000	1.000	1.000	2.333	3.640
vocanonagg | bruna	8	1.000	2.000	1.000	1.000	1.500	2.000	1.500	0.535
vocanonagg | frisona	9	1.000	6.000	5.000	2.000	3.000	4.000	3.111	1.900
vocanonagg | modenese	8	1.000	2.230	1.230	2.230	2.230	2.230	2.076	0.435
vocanonagg | rendena	6	1.000	7.000	6.000	1.000	1.000	1.000	2.000	2.449
vocanonagg | varzese	9	1.000	10.000	9.000	1.000	1.000	6.000	3.778	3.492

Table 6.3. Descriptive statistics for each breed

The results for the Kruskal-Wallis test are reported in table 6.4. Eight variables out of 26 differ between breeds in median values

Variable\Test	Kruskal-Wallis
Active	**0.001**
Agvcon	**0.007**
Agvkn	0.125
agvunk	**0.002**
agvkeeper	0.209
Calm	**0.000**
Coop	0.055
curious	**< 0.0001**
Excit	0.139
frvcon	0.284
frvkeeper	**0.048**
Frvkn	**0.000**
frvunk	**0.015**
dominant	0.075
fearcon	**0.001**
fearkn	**0.045**
fearunk	**0.001**
fearkeeper	0.248
insecure	**0.012**
playful	**< 0.0001**
selfass	**< 0.0001**
smart	**0.001**
Tense	**0.001**
Shy	**< 0.0001**
vocaggr	**0.003**
vocanonagg	0.137

Table 6.4. Results for the Kruskal-Wallis test

Besides the univariate analysis of the variables, a multivariate analysis of data was applied: the multifactor analysis (MFA) was chosen for our purposes. It is a particular kind of principal component analysis involving several groups of variables instead of a single group (Escofier and Pagès, 2008). In our case, two groups of variables were analyzed: the measured variables on one side, and the breed on the other.

The MFA analysis gave, on the basis of the first 5 dimensions, the results reported in table 6.5. Table 6.5 presents MFA results for the cows. The table reports for each dimension (Dim.X) correlations of the quantitative (quanti) and qualitative (quali) variables (e.g. the breed).

For each dimension, quantitative variables can be negatively or positively correlated. The same is true for breed.

Henceforth, if we take in consideration the first dimension (Dim.1), we can notice that Rendena breed is positively correlated with positively correlated values (from insecure to vocal :aggressive) . On the other hand, Bruna, with a negative correlation, is positively correlated with the negative variables of Dim.1 (from cooperative to friendly vs keepers/milkers) showing an opposite trend compared to Rendena.

Dim.1

	correlation	p.value
insecure	0.7905	0
fearcon	0.7849	0
agvunk	0.7488	0
shy	0.7473	0
fearkn	0.7183	0
dominant	0.7103	0
agvkeeper	0.7094	0
excit	0.7004	0
fearunk	0.6916	0
fearkeeper	0.6467	0
agvkn	0.5945	1.00E-04
active	0.4313	0.0055
agvcon	0.4073	0.0091
vocanonagg	0.3122	0.0499
coop	-0.4143	0.0079
frvcon	-0.4219	0.0067
playful	-0.6859	0
selfass	-0.6968	0
smart	-0.6976	0
frvkn	-0.7486	0
frvkeeper	-0.8092	0

	R2	p.value
breed	0.5776	0

category

	Estimate	p.value
rendena	2.3063	8.00E-04

bruna	-2.5153	1.00E-04

Dim.2

	correlation	p.value
curious	0.881	0
agvcon	0.6789	0
selfass	0.6071	0
playful	0.5113	7.00E-04
vocanonagg	0.4414	0.0044
excit	0.4315	0.0054
active	0.4248	0.0063
tense	0.4236	0.0065
smart	0.4025	0.01
agvunk	0.3857	0.014
vocaggr	0.3444	0.0296
frvunk	-0.329	0.0382
calm	-0.5792	1.00E-04
coop	-0.613	0

	R2	p.value
breed	0.8212	0

category

	Estimate	p.value
varzese	1.8538	0
modenese	-2.4707	0

Dim.3

	correlation	p.value
active	0.5919	1.00E-04
frvunk	0.5113	7.00E-04
agvcon	0.3327	0.0359
agvkn	0.3122	0.0499
shy	-0.3409	0.0314

	R2	p.value
breed	0.9077	0

category

	Estimate	p.value
modenese	1.3272	0.0017
varzese	1.212	0.0023
rendena	-2.083	0

Dim.4

	correlation	p.value
fearunk	0.3544	0.0249
shy	0.3513	0.0262
agvunk	0.3255	0.0404
fearkeeper	-0.3742	0.0174

	R2	p.value
breed	0.7881	0

category

	Estimate	p.value
varzese	1.1132	2.00E-04
frisona	-1.624	0

Dim.5

	correlation	p.value
fearkeeper	0.4603	0.0028
agvkeeper	0.3436	0.03

	R2	p.value
breed	0.6729	0

category

	Estimate	p.value
bruna	1.3618	0
frisona	-1.1161	1.00E-04

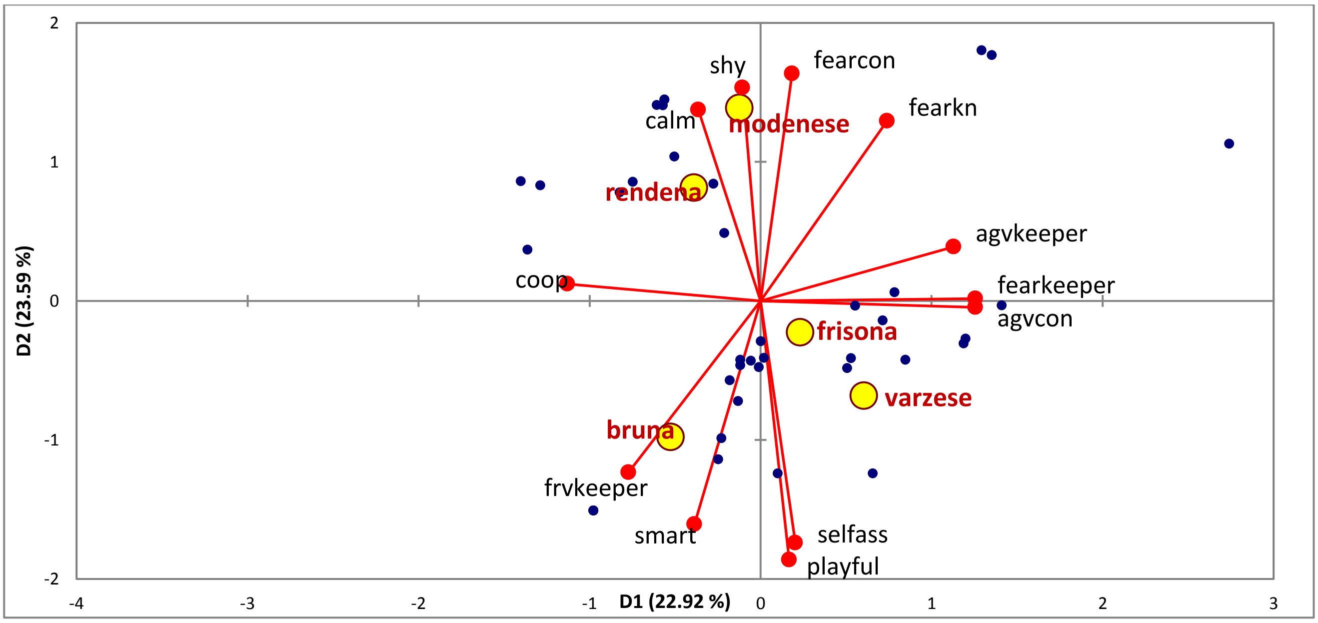


Fig.6.2. Projection of the most relevant variables and the breeds on the space of the first two components

6.5 CONCLUSION

The extensive data analysis presented above indicates the proposed questionnaire ability in screening individual differences in cattle personality. Originally developed to assess felid personality (Gartner and Powel, 2011; Chadwick, 2014), its validity for another mammal shows potentiality as a standardized research methodology to investigate personality in different taxa.

This study indicates that there are certain personality traits shared in each of the five dairy breeds screened. Interestingly Holstein Frisian (Frisona) is the less reactive and" inert" of the breeds considered (Fig.6.2). Could this be related to the fact that this breed has been selected for a long time to living and husbandry regimes in intensive dairy farms?

Varzese breed distinguish herself as the most "curious" of the five while Rendena is the shyest but most dominant and aggressive towards unknown people. We suggest that this may be connected to the traditional husbandry regimes these breeds have been selected for during centuries of captive breeding.

Most of these breeds had a triple attitude: dairy, beef and work. They were selected to work in small farms, in small numbers, interacting with few owners and humans for different tasks and always aware of the physical and social environment around them.

Even today they survive in small numbers in small, local, farms that changed little of the classic husbandry regimes compared to the intensive farming that Holstein Frisian was subject to.

We hope that this pilot study will lead to farther research on cattle personality, widening the sample of screened individuals and breed types, in order to preserve rare breeds personality characteristics along with their genetic , morphological and productive distinctiveness.

REFERENCES

Acquarone C, Cucco M, Malacarne G. 2002. Annual variation of immune condition in the Hooded Crow (Corvus corone cornix). Journal Fur Ornithologie 143(3):351-355.

Anderson C, Arun AS, Jensen P. 2010. Habituation to environmental enrichment in captive sloth bears—effect on stereotypies. Zoo Biol 29(6):705-14.

Asa, C. S., Traylor-Holzer, K., & Lacy, R. C. (2011). Can conservation-breeding programmes be improved by incorporating mate choice? International Zoo Yearbook, 45(1), 203-212.

Baker K, Pullen K. 2013. The impact of housing and husbandry on the personality of cheetah (Acinonyx jubatus). J Zoo Aquar Res 1(1):35-40.

Ballou JD, Lees C, Faust LJ, Long S, Lynch C, Lackey LB, Foose TJ. 2010. Demographic and genetic management of captive populations. In: Devra G. Kleiman KVT, Charlotte Kirk Baer, editor. Wild Mammals in Captivity: Principles and Techniques for Zoo Management.

Bashaw MJ, Kelling AS, Bloomsmith MA, Maple TL. 2007. Environmental Effects on the Behavior of Zoo-housed Lions and Tigers, with a Case Study o the Effects of a Visual Barrier on Pacing. J Appl Anim Welf Sci 10(2):95-109.

Bauer E, Babitz M, Boedeker N, Hellmuth H. 2013. Approaches to understanding and managing pacing in sloth bears in a zoological setting. International Journal of Comparative Psychology 26(1).

Birgersson S. 2011. Personality assessment and interactions in eight captive bottlenose dolphins (Tursiops truncatus) [Master's Thesis]: Linköpings universitet.

Blumstein, D. T., Holland, B. D., & Daniel, J. C. (2006). Predator discrimination and ‘personality’ in captive Vancouver Island marmots (Marmota vancouverensis). Animal Conservation, 9(3), 274-282.

Boysen, S.T., 1992. Pongid pedagogy: the contribution of human-chimpanzee interactions in the study of ape cognition. In: Davis, H., Balfour, D. (Eds.), The Inevitable Bond: Examining scientist-animal interactions. Cambridge University Press, pp. 205–217.

Borgatti, SP., Everett, MG. and Freeman, LC. 2002. Ucinet for Windows: Software for Social Network Analysis. Harvard, MA: Analytic Technologies.

Breitenmoser U, Mallon DP, Ahmad Khan J, Driscoll C. 2008. Panthera leo ssp. persica. The IUCN Red List of Threatened Species 2008. e.T15952A5327221 ed.

Bremner-Harrison S, Prodohl P, Elwood RW. 2004. Behavioural trait assessment as a release criterion: boldness predicts early death in a reintroduction programme of captive-bred swift fox (Vulpes velox). Anim Conserv 7(03):313-320.

Burghardt, G.M., 1992. Human-bear bonding in research on black bear behaviour. In: Davis, H., Balfour, D. (Eds.), The Inevitable Bond: Examining scientist-animal interactions. Cambridge University Press, pp. 365–382.

Carlstead K, Brown JL, Seidensticker J. 1993. Behavioral and adrenocortical responses to environmental changes in leopard cats (Felis bengalensis). Zoo Biol 12(4):321-331.

Carlstead, K., Fraser, J., Bennett, C., & Kleiman, D. G. (1999). Black rhinoceros (Diceros bicornis) in U.S. zoos: II. Behaviour, breeding success and mortality in relation to housing facilities. Zoo Biology, 18(1), 35-52.

Carlstead K, Mellen J, Kleiman DG. 1999. Black rhinoceros (Diceros bicornis) in U.S. zoos: I. individual behavior profiles and their relationship to breeding success. Zoo Biol 18(1):17-34.

Carlstead, K., Shepherdson, D. J., Sheppard, C., Mellen, J., Ogden, J., & Bennett, C. (2000). Constructing Behaviour Profiles of Zoo Animals: Incorporating Behavioural Information into Captive Population Management. Oregon Zoo: American Zoo and Aquarium Association's Behaviour and Husbandry Advisory Group.

Carlstead, K., Brown, J.L., 2005. Relationships between patterns of fecal corticoid excretion and behavior, reproduction, and environmental factors in captive black (Diceros bicornis) and white (Ceratotherium simum) rhinoceros. Zoo Biol. 24, 215–232.

Cassini, M.H., 2001. Behavioural responses of South American fur seals to approach by tourists—a brief report. Appl. Anim. Behav. Sci. 71, 341–346.

Chadwick C. 2014. Social behaviour and personality assessment as a tool for improving the management of cheetahs (Acinonyx jubatus) in captivity [Dissertation]: University of Salford.

Chamove, A.S., Hosey, G.R., Schaetzel, P., 1988. Visitors excite primates in zoos. Zoo Biol. 7, 359–369.

Chang, F.T., Hart, L.A., 2002. Human-animal bonds in the laboratory: how the animal behavior affects the perspectives of caregivers. ILAR J. 43, 10–18.

Cicchetti DV. 1994. Guidelines, criteria, and rules of thumb for evaluating normed and standardized assessment instruments in psychology. Psychol Assessment 6(4):284.

Cinková, I. and Bičík, V. 2013. Social and reproductive behaviour of critically endangered northern white rhinoceros in a zoological garden. Mammalian Biology – Zeitschrift fur Saugetierkunde, 78: 50–54.

Clubb R, Vickery S. 2006. Locomotory stereotypies in carnivores: does pacing stem from hunting, ranging, or frustrated escape? In: Mason GJ, Rushen J, editors. Stereotypic Animal Behaviour: Fundamentals and Applications to Welfare. 2nd ed: Centre for Agriculture and Bioscience International. p 58-79.

Coleman, K. & Wilson, D. S. (1998). Shyness and boldness in pumpkinseed sunfish: individual differences are context-specific. Anim. Behav. 56: 927–936.

Coleman, K., Tully, LA., McMillan, JL. 2005. Temperament correlates with training success in adult rhesus macaques. American journal of primatology, 65, 63-71.

Costa, P. T., & McCrae, R. R. (1992). Neo PI-R professional manual. Odessa, FL: Psychological.

Communod R., Faustini M., Munari E., Colombani C., Castagna G., Comi M., Torre M.L., Chlapanidas T., Lucconi G., Lazzati M., Vigo D. (2010) Future perspectives of Varzese breed in an innovative biodiversity enhancement process. Large Animal Review, 16, 267-271

Communod R., Faustini M, Chiesa L.M., Torre M.L., Lazzati M. and Daniele Vigo (2011). Milk biodiversity: future perspectives of milk and dairy products from autochthonous dairy cows reared in northern Italy. Chapter from Review Book Food Production. Publisher: InTech, 169-184.

Curone G., Zanini M., Panseri S., Colombani C., Moroni P., *et al.* (2016) Milk Ketone Bodies Assessment in A Local Italian Cow Breed (Modenese) vs. Holstein and Characterization of its Physiological, Reproductive and Productive Performances. Int J Envir Agr Res 2: 15-22.

Davis, N., Schaffner, C.M., Smith, T.E., 2005. Evidence that zoo visitors influence HPA activity in spider monkeys (Ateles geoffroyii rufiventris). Appl. Anim. Behav. Sci. 90, 131–141.

DeshGujarat. 2015 Asiatic Lion population up from 411 to 523 in five years.

Dewsbury, D.A., 1992. Studies of rodent-human interactions in animal psychology. In: Davis, H., Balfour, D. (Eds.), The Inevitable Bond: Examining scientist-animal interactions. Cambridge University Press, pp. 27–43.

Dickens, M. 1955. A statistical formula to quantify the spread of participation in group discussion. Speech Mon. 22: 28-31.

Duclos, D.R.; Hiemstra, S. J., 2010: State of local cattle breeds in Europe. In: S. J. Hiemstra, Y. de Haas, A. Maki-Tanila, G. Gandini (eds), Local Cattle Breeds in Europe. EU GENRES 870/ 04 project EURECA. Wageningen Academic Publishers, Wageningen, pp. 40–55.

Escofier, B. & Pagès, J. (2008). Analyses factorielles simples et multiples ; objectifs, méthodes et interprétation. Dunod, Paris.

Fagen R and Fagen JM. 1996. Individual distinctiveness in brown bears *Ursus arctos*, L. Ethology 102(2):212-26.

Fentress, J.C., 1992. The covalent animal: on bonds and their boundaries in behavioural research. In: Davis, H., Balfour, D. (Eds.), The Inevitable Bond: Examining scientist–animal interactions. Cambridge University Press, pp. 44–71.

Forkman, B., Boissy, A., Meuniersalaun, M., Canali, E., & Jones, R. 2007. A critical review of fear tests used on cattle, pigs, sheep, poultry and horses.Physiology & Behavior, 92, 340–374.

Fraser, D. 2008. Toward a global perspective on farm animal welfare. Applied Animal Behaviour Science, 113, 330–339.

Freeman, E. W., Weiss, E., & Brown, J. L. (2004). Examination of the interrelationships of behaviour, dominance status, and ovarian activity in captive Asian and African elephants. Zoo Biology, 23(5), 431-448.

Freeman HD, Gosling SD. 2010. Personality in Nonhuman Primates: A Review and Evaluation of Past Research. Am J Primatol 72(8):653-671.

Freedman, D.A. (2009). Statistical Models: Theory and Practice. Cambridge University Press. p. 128.

Gartner MC, Powell D. 2012. Personality assessment in snow leopards (Uncia uncia). Zoo Biol 31(2):151-165.

Gartner MC, Weiss A. 2013. Personality in felids: A review. Appl Anim Behav Sci 144(1-2):1-13.

Gartner, M. C.; Powell, D. M.; Weiss, A. (2014). Personality structure in the domestic cat (*Felis silvestris catus*), Scottish wildcat (*Felis silvestris grampia*), clouded leopard (*Neofelis nebulosa*), snow leopard (*Panthera uncia*), and African lion (*Panthera leo*): A comparative study. Journal of Comparative Psychology, Vol 128(4), Nov 2014, 414-426.

Gibbons, J. M., Lawrence, A. B., & Haskell, M. J. 2009. Consistency ofaggressive feeding behaviour in dairy cows. Applied Animal Behaviour Science,121, 1–7.

Goldberg, L. R., 1993. The structure of phenotypic personality traits. American Psychologist 48, 26-34.

Gosling S.D. 2001. From mice to men: what can we learn about personality from animal research? Psychol Bull 127(1):45.

Gosling S.D. 2008. Personality in Non-human Animals. Soc Personal Psychol Compass 2(2):985-1001.

Gosling, S. D., John, O. P., 1999. Personality dimensions in nonhuman animals: A cross-species review. American Psychological Society 8, 69-75.

Gurven, M., Von Rueden, C., Massenkoff, M., Kaplan, H., & Lero Vie, M. 2012.How universal is the Big Five? Testing the Five-Factor Model of Personality variation among forager-farmers in the Bolivian Amazon. Journal of Personality and Social Psychology, 104, 354–370.

Hansen S.W, Jeppesen LL. 2006. Temperament, stereotypies and anticipatory behaviour as measures of welfare in mink. Appl Anim Behav Sci 99(1):172-182.

Hemsworth, P.H., 2003. Human–animal interactions in livestock production. Appl. Anim. Behav. Sci. 81, 185–198.

Hemsworth, P.H., Gonyou, H.W., 1997. Human Contact. In: Appleby, M.C., Hughes, B.O. (Eds.), AnimalWelfare. CAB International, Wallingford UK, pp. 205–217.

Hemsworth, P.H., Barnett, J.L., Coleman, G.J., 1993. The human–animal relationship in agriculture and its consequences for the animal. Anim. Welf. 2, 33–51.

Hediger, H., 1970. Man and Animal in the Zoo. Routledge & Kegan Paul, London.

Highfill, L. E., Kuczaj, S. A., 2007. Do bottlenose dolphins (*Tursiops truncatus*) have distinct and stable personalities? Aquatic mammals 33(3), 380-389.

Highfill L, Hanbury D, Kristiansen R, Kuczaj S, Watson S. 2010. Rating vs. Coding in Animal Personality Research. Zoo Biol 29(4):509-516.

Hill SP, Broom DM. 2009. Measuring zoo animal welfare: theory and practice. Zoo Biol 28(6):531-544.

Hosey, G.R., 2000. Zoo animals and their human audiences: what is the visitor effect? Anim. Welf. 9, 343–357.

Hosey, G., 2008. A preliminary model of human–animal relationships in the zoo. Appl. Anim. Behav. Sci. 109, 105–127.

Hosey, G., Melfi, V., & Pankhurst, S. (2013). Zoo Animals: Behaviour, Management and Welfare (2nd ed.). Oxford: Oxford University Press.

Joslin P. 1973. The Asiatic Lion: A study of ecology and behaviour [Dissertation]. Edinburgh: University of Edinburgh.

Kiley-Worthington M. 1976. The tail movements of ungulates, canids and felids with particular reference to their causation and function as displays. Behaviour 56(1):69-114.

Kleiman D.G, Thompson K.V., Baer C.K. 2010. Wild mammals in captivity: Principles and techniques for zoo management. University of Chicago Press.

Kreger, M.D., Mench, J.A., 1995. Visitor-animal interactions at the zoo. Anthrozoo¨s 8, 143–158.

Kuhar, C. W., Stoinski, T. S., Lukas, K. E., & Maple, T. L. (2006). Gorilla Behaviour Index revisited: age, housing and behaviour. Applied Animal Behaviour Science, 96(3-4), 315-326.

Kwan, V. S. Y., Gosling, S. D., & John, O. P. (2008). Anthropomorphism as a special case of social perception: a cross-species social relations model analysis of humans and dogs. Social Cognition, 26(2), 129-142.

Leyhausen P. Cat behavior: the predatory and social behavior of domestic and wild cats. Garland STPM Press: New York, 1979

Liberg O, Sandell M. 1988. Spatial organisation and reproductive tactics in the domestic cat and other filids. In: Dennis C. Turner PB, editor. Domestic Cat: The Biology of its Behavior: Cambridge University Press.

Lodé T. 2008. Kin recognition versus familiarity in a solitary mustelid, the european polecat *Mustela putorius*. Comptes Rendus Biologies 331(3):248-54.

Lyons J, Young RJ, Deag JM. 1997. The effects of physical characteristics of the environment and feeding regime on the behavior of captive felids. Zoo Biol 16(1):71-83.

MacKay, J. R. D., Turner, S. P., Hyslop, J. J., Deag, J. M., & Haskell, M. J. 2013. Short-term temperament tests in beef cattle relate to long term measures of behavior recorded in the home pen. Journal of Animal Science, in press.

Mallapur, A., Chelan, R., 2002. Environmental influences on stereotypy and the activity budget of Indian leopards (Panthera pardus) in four zoos in southern India. Zoo Biol. 21, 585–595.

Margulis, S.W., Hoyos, C., Anderson, M., 2003. Effect of felid activity on zoo visitor interest. Zoo Biol. 22, 587–599.

Martin P, Bateson P. 2007. Measuring Behaviour: An Introductory Guide. 3rd ed. ed: Cambridge University Press.

Mason GJ. 1991. Stereotypies: a critical review. Anim Behav 41(6):1015-1037.

MacHutchon A.G. 2001. Grizzly bear activity budget and pattern in the firth river valley, yukon. Ursus :189-98.

Melfi, V.A., Thomas, S., 2005. Can training zoo-housed primates compromise their conservation? A case study using Abyssinian colobus monkeys (Colobus guereza). Anthrozoo¨s 18, 304–317.

Meagher, R. K. (2009). Observer ratings: validity and value as a tool for animal welfare research. Applied Animal Behaviour Science, 119(1-2), 1-14.

Mellen, J., 1991. Factors influencing reproductive success in small captive exotic felids (Felis spp.): a multiple regression analysis. Zoo Biol. 10, 95–110.

Mellen J, MacPhee MS. 2001. Philosophy of environmental enrichment: Past, present, and future. Zoo Biol 20(3):211-226.

Micheletta, J. and Waller, BM. 2012. Friendship affects gaze following in a tolerant species of macaque, Macaca nigra. Animal Behaviour, 83: 459–467.

Mitchell, G., Obradovich, S.D., Herring, F.H., Dowd, B., Tromborg, C., 1991a. Threats to observers, keepers, visitors, and others by zoo mangabeys (Cercocebus galeritus chrysogaster). Primates 32, 515–522.

Mitchell, G., Herring, F., Obradovich, S., Tromborg, C., Dowd, B., Neville, L.E., Field, L., 1991b. Effects of visitors and cage changes on the behaviors of mangabeys. Zoo Biol. 10, 417–423.

Mitchell, G., Tromborg, C.T., Kaufman, J., Bargabus, S., Simoni, R., Geissler, V., 1992c. More on the ‘influence’ of zoo visitors on the behaviour of captive primates. Appl. Anim. Behav. Sci. 35, 189–198.

Montaudouin S and Le Pape G. 2005. Comparison between 28 zoological parks: Stereotypic and social behaviours of captive brown bears (*Ursus arctos*). Appl Anim Behav Sci 92(1):129-41.

Munkwitz NM, Turner JM, Kershner EL, Farabaugh SM, Heath SR. 2005. Predicting release success of captive-reared loggerhead shrikes (Lanius ludovicianus) using pre-release behavior. Zoo Biol 24(5):447-458.

O’Donovan, D., Hindle, J.E., McKeown, S., O’Donovan, S., 1993. Effect of visitors on the behaviour of female cheetahs *Acinonyx jubatus*. Int. Zoo Ybk 32, 238–244.

Pavlov IP. 1906. The Scientific Investigation of the Psychical Faculties or Processes in the Higher Animals. Science 24(620):613-619.

Pepperberg, I.M., 1992. Social interaction as a condition for learning in avian species: a synthesis of the disciplines of ethology and psychology. In: Davis, H., Balfour, D. (Eds.), The Inevitable Bond: Examining scientist-animal interactions. Cambridge University Press, pp. 178–204.

Perret M. and Predine J. 1984. Effects of long-term grouping on serum cortisol levels in *Microcebus murinus* (*prosimii*). Horm Behav 18(3):346-58.

Pervin, L. A., Crevone, D., 2010. Personality: Theory and research (11th ed.). John Wiley & Sons, New York, pp. 7-9.

Petrera, F., Napolitano, F., Dal Prà, A., & Abeni, F. (2014). Plasma parameters related to energy and lipid metabolism in periparturientModenese and Italian Friesian cows. Journal of animal physiology and animal nutrition.99(5):962-73

Phillips C., Peck D. 2007. The effects of personality of keepers and tigers (*Panthera tigris tigris*) on their behaviour in an interactive zoo exhibit. Appl. Anim. Behav. Sci. 106(4):244-258.

Plowman AB. 2003. A note on a modification of the spread of participation index allowing for unequal zones. Appl Anim Behav Sci 83(4):331-336.

Powell DM, Gartner MC. 2011. Applications of Personality to the Management and Conservation of Nonhuman Animals. In: Inoue-Murayama M, Kawamura S, Weiss A, editors. From Genes to Animal Behavior: Social Structures, Personalities, Communication by Color. Tokyo: Springer Japan. p 185-199.

Pullen, PK. 2009. Male-male social interactions in breeder and bachelor groups of gorillas (*Gorilla gorilla*): An indication of behavioural flexibility. [dissertation], Exeter, University of Exeter.

Ramesh T., Kalle R., Sankar K., Qureshi Q. 2013. Activity pattern of sloth bear *Melursus ursinus* (*Mammalia: Ursidae*) in mudumalai tiger reserve, western ghats, india. Journal of Threatened Taxa 5(5):3989-92.

Réale, D., Reader, S. M., Sol, D., McDougall, P. T., & Dingemanse, N. J. (2007). Integrating animal temperament within ecology and evolution. Biological Reviews, 82(2), 291-318.

Rees, P. A. (2011). An Introduction to Zoo Biology and Management. Oxford: Wiley-Blackwell.

Rees PA. 2015. Studying Captive Animals: A Workbook of Methods in Behaviour, Welfare and Ecology. John Wiley & Sons.

Rose P. and Robert R. 2013. Evaluating the activity patterns and enclosure usage of a little-studied zoo species, the sitatunga (*Tragelaphus spekii*). Journal of Zoo and Aquarium Research 1(1):14-9.

Rudnai, JA. 1973. Social life of the lion: a study of the behaviour of wild lions (Panthera leo massaica) in the Nairobi national park, Kenya. Washington square east publishers.

Schaller GB. 1972. The Serengeti Lion: A Study of Predator-Prey Relations. University of Chicago Press.

Sellinger, R.L., Ha, J.C., 2005. The effects of visitor density and intensity on the behavior of two captive jaguars (*Panthera onca*). JAAWS 8, 233–244.

Servheen C, Herrero S, Peyton B, Pelletier K, Moll K, Moll J. 1999. Bears: Status survey and conservation action plan. IUCN.

Seryodkin I., Kostyria A., Goodrich J., Miquelle D. 2013. Daily activity patterns of brown bear (*Ursus arctos*) of the sikhote-alin mountain range (Primorskiy krai, Russia). Russian J. Ecol 44(1):50-5.

Shepherdson D.J., Mellen J.D., Hutchins M. 2012. Second nature: Environmental enrichment for captive animals. Smithsonian Institution.

Shrout PE, Fleiss JL. 1979. Intraclass correlations: uses in assessing rater reliability. Psychol Bull 86(2):420.

Soares N., Quintavalle Pastorino G., 2015. Personality Assessment and Feline-Keepers Relationship in Lion (*Panthera Leo*) [Master's Thesis]: Royal Veterinary College, University of London.

Stanton L.A., Sullivan M.S., Fazio J.M. 2015. A standardized ethogram for the felidae: A tool for behavioral researchers. Appl Anim Behav Sci 173:3-16.

Swaisgood R, Shepherdson D. 2006. Environmental enrichment as a strategy for mitigating stereotypies in zoo animals: a literature review and meta-analysis. In: Mason GJR, J, editor. Stereotypic Animal Behaviour: Fundamentals and Applications to Welfare. 2nd ed: Centre for Agriculture and Bioscience International. p 256-285.

Szokalski, M. S., Foster, W. K., & Litchfield, C. A. (2013). Behavioral monitoring of big cats involved in 'behind-the-scenes' zoo visitor tours. International Journal of Comparative Psychology, 26,82-104.

Tarakini, T., Chikerema, F. ,Muposhi, V. 2014. Activity Budgets and Time Treatments of Lion (*Panthera leo*) Cubs under Human Imprinting at Antelope Park, Gweru, Zimbabwe. International Journal of Molecular Ecology and Conservation, 4.

Tetley, C & O'Hara, S 2012, 'Ratings of animal personality as a tool for improving the breeding, management and welfare of zoo animals', Animal Welfare, 21(4), pp.463-476.

Tett P, Gowen RJ, Painting SJ, Elliott M, Forster R, Mills DK, Bresnan E, Capuzzo E, Fernandes TF, Foden J, Geider RJ, Gilpin LC, Huxham M, McQuatters-Gollop AL, Malcolm SJ, Saux-Picart S, Platt T, Racault MF, Sathyendranath S, van der Molen J, Wilkinson M. 2013. Framework for understanding marine ecosystem health. Marine Ecology Progress Series 494:1-27.

Thurstone, L. L., 1934. The vectors of mind. The Psychological Review 41(1), 1-32.

TPWD. 2016. Chronic Wasting Disease. In: Department TPaW, editor: State of Texas.

Uher, J. 2008. Comparative personality research: methodological approaches. European journal of personality, 22, 427-455.

USDA. 2014. Chronic Wasting Disease: Program Standards. United States Deparment of Agriculture: Animal and Plant Health Inspection Service.

Varotto, A., De Marchi, M., Penasa, M., & Cassandro, M. (2015). A comparison of milk clotting characteristics and quality traits of Rendena and Holstein-Friesian cows. Italian Journal of Animal Science, 14(2), 3768.

Van Reenen, C. G. 2012. Identifying temperament in dairy cows. A longitudinal approach. PhD Thesis- University of Wageningen.

Vazire S., Gosling S.D., Dickey A.S., Schapiro S.J. 2007. Measuring personality in nonhuman animals. Handbook of Research Methods in Personality Psychology :190-206.

Veeraselvam M., Sridhar R., Jayathangaraj M., Perumal P. 2013. Behavioural study of captive sloth bears using environmental enrichment tools. International Journal of Zoology 2013.

Walker, S.H.; Duncan, D.B. (1967). "Estimation of the probability of an event as a function of several independent variables". Biometrika. 54: 167–178.

Watters JV, Powell DM. 2012. Measuring Animal Personality for Use in Population Management in Zoos: Suggested Methods and Rationale. Zoo Biol 31(1):1-12.

Wedl, M.; Bauer, B.; Gracey, D.; Grabmayer, C.; Spielauer, E.; Day, J.; Kotrschal, K. (2011). Factors influencing the temporal patterns of dyadic behaviours and interactions between domestic cats and their owners. Behavioural Processes, 86, 58-67.

Wedekind, C. (2002). Sexual selection and life history decisions: implications for supportive breeding and the management of captive populations. Conservation Biology, 16(5), 1204-1211.

Weather.com. 2016. Weather Today. The Weather Channel.

Wedl, M. et al., 2011. Factors influencing the temporal patterns of dyadic behaviours and interactions between domestic cats and their owners. Behavioural processes, 86, 58-67.

Weinstein, T. A. R., Capitanio, J. P., & Gosling, S. D. (2008). Personality in animals. In O. P. John, R. W. Robins & L. A. Pervin (Eds.), Handbook of Personality: Theory and Research (3rd ed., pp. 328-348). New York: Guilford Press.

Wells, A., Terio, K. A., Ziccardi, M. H., & Munson, L. (2004). The stress response to environmental change in captive cheetahs (Acinonyx jubatus). Journal of Zoo and Wildlife Medicine, 35(1), 8-14.

White, LLT., Bennett, C. 2014. Rating methodology, personality axes, and behavioural plasticity: a case study in African lions. Animal behaviour and cognition, 1(3), 230-248.

Whitham, J. C., & Wielebnowski, N. (2009). Animal-based welfare monitoring: using keeper ratings as an assessment tool. Zoo Biology, 28(6), 545-560.

Whitham, J. C., & Wielebnowski, N. (2013). New directions for zoo animal welfare science. Applied Animal Behaviour Science, 147(3–4), 247-260.

Wielebnowski NC. 1999. Behavioral differences as predictors of breeding status in captive cheetahs. Zoo Biol 18(4):335-349.

Wielebnowski, N.C., Fletchall, N., Carlstead, K., Busso, J.M., Brown, J.L., 2002. Noninvasive assessment of adrenal activity associated with husbandry and behavioral factors in the North American clouded leopard population. Zoo Biol. 21, 77–98.

Weiss, A., Inoue-Murayama, M., Hong, K.-W., Inoue, E., Udono, T., Ochiai, T., Matsuzawa, T., Hirata, S., & King, J. E. (2009). Assessing chimpanzee personality and subjective well-being in Japan. American Journal of Primatology, 71(4), 283-292.

Weiss, A., Inoue-Murayama, M., King, J. E., Adams, M. J., & Matsuzawa, T. (2012). All too human? Chimpanzee and orang-utan personalities are not anthropomorphic projections. Animal Behaviour, 83(6), 1355-1365.

Weiss, A., King, J. E., & Enns, R. M. (2002). Subjective well-being is heritable and genetically correlated with Dominance in chimpanzees (Pan troglodytes). Journal of Personality and Social Psychology, 83(5), 1141-1149.

Weiss, A., King, J. E., & Figueredo, A. J. (2000). The heritability of personality factors in chimpanzees (Pan troglodytes). Behaviour Genetics, 30(3), 213-221.

Weiss, A., King, J. E., & Hopkins, W. D. (2007). A cross-setting study of chimpanzee (Pan troglodytes) personality structure and development: zoological parks and Yerkes National Primate Research Centre. American Journal of Primatology, 69(11), 1264-1277.

Yoerg S.I. 1999. Solitary is not asocial: Effects of social contact in kangaroo rats (Heteromyidae: *Dipodomys heermanni)*. Ethology 105(4):317-33.

APPENDIX 1: Ethogram

State Behaviour	***Description***
*Out of sight (**OOS**)*	Beyond one's range of vision
*Decubitus – Dorsal (**DD**)*	Lays down on the dorsum
*Decubitus – Lateral (**LD**)*	Lays down laterally
*Decubitus – Lateral – Legs Raised (**DLLR**)*	Lays down laterally, one back leg raised
*Decubitus – Sternal (**SD**)*	Lays down on the sternum
*Sternal – Sphynx (**SPH**)*	Lays down on the sternum, back legs parallel and orientated forward
*Sternal – Lunula (**LUN**)*	Lays down on the sternum, legs put to one side
*Ears forward (**EF**)*	Ears oriented forward
*Ears backwards (**EB**)*	Ears oriented backward
*Facing conspecific (**FC**)*	Stares at another animal of the same species
*Facing observer (**FO**)*	Stares at the observer
*Facing public (**FP**)*	Stares at the public
*Proximity to conspecific – body length (**BL**)*	Within one body length of other animal
*Proximity to conspecific – far (**F**)*	More than one body length away from the other animal
*Proximity to conspecific – contact (**C**)*	In body contact with conspecific
*Sitting (**SIT**)*	Upright position, all four feet on ground, front legs straight, back legs folded
*Standing (**STA**)*	Stands with all four legs extended, paws on the ground, immobile

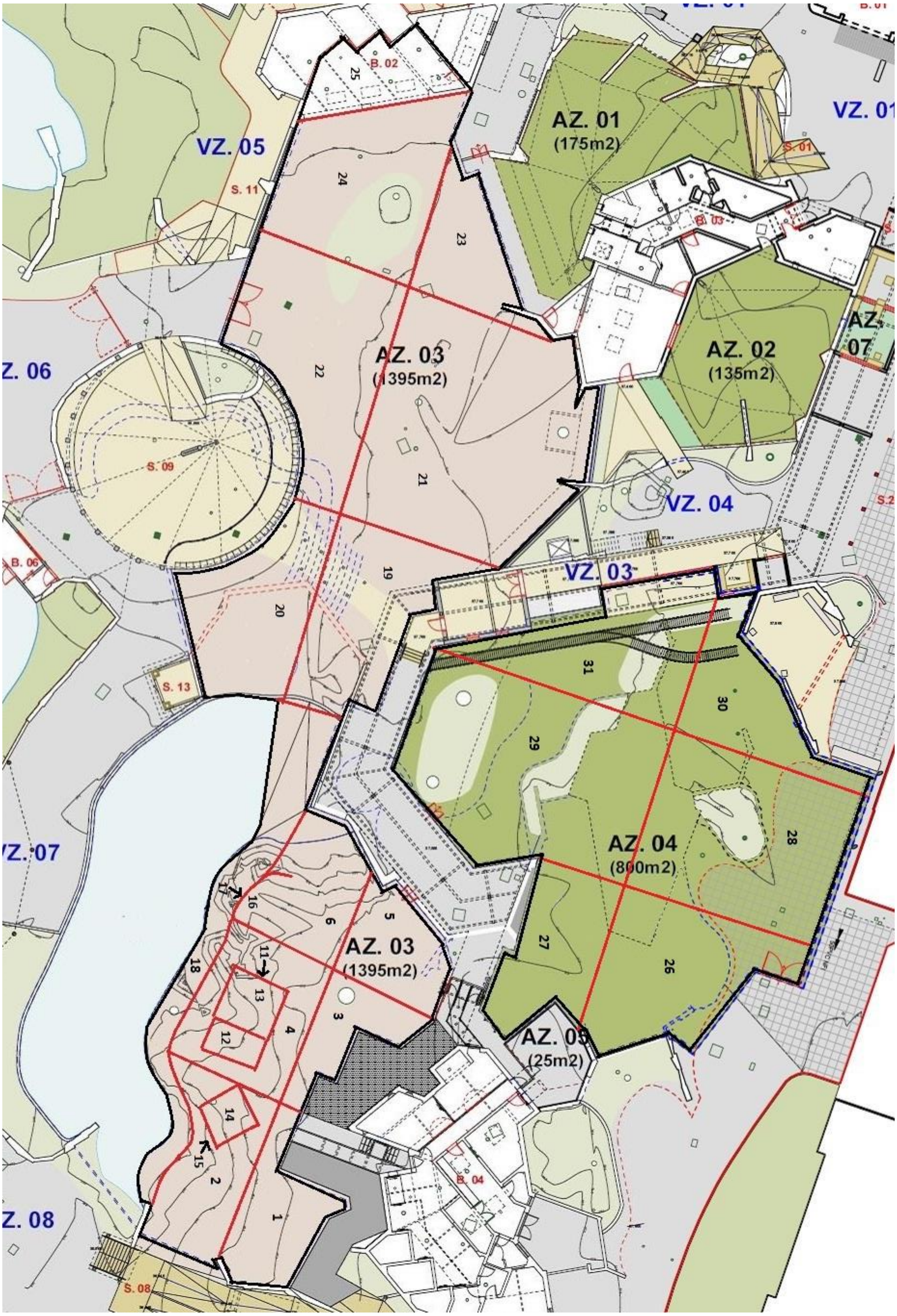
Event Behaviour	**Description**
*Allogroom (**AG X**) x is the animal*	Licks the fur of a conspecific
*Allogroomed (**AGD b X**)*	Has the fur licked by a conspecific
*Bare teeth (**BAT X a**) a for active*	Animal opens its mouth and pulls the lips back, exposing its teeth
*Receiving bare teeth (**BAT X p**) p for passive*	Is on the receiving end of bared teeth
*Bite (**BT X**)*	Mouth closes on object or conspecific
*Bitten (**BT b X**)*	Is bitten by conspecific
*Belly up (**B UP**)*	Animal lies on its back with throat and belly exposed to the opponent
*Belly up defensive posture (**B UP DP**)*	Animal lies on its back with bared teeth, all four paws up with claws unsheathed
*Chase (**CH X**)*	Runs after conspecific or other being/object
*Chased (**CHD b X**)*	Pursued by conspecific
*Climb up (**CU**)*	Ascends an object or structure

Event Behaviour	**Description**
*Climb down (**CD**)*	Descends an object or structure
*Defensive open mouth (**DOM X**)*	Mouth wide open in defensive stance
*Drink (**DR**)*	Lapps up water and swallows
*Defecate (**DF**)*	Relieves colon, releases faeces
*Eat (**EAT**)*	Ingests food by chewing and swallowing
*Eat Grass (**EAG**)*	Ingest grass by chewing
*Stretching (**STR**)*	Extend all body and forelegs forward and put the back and tail up
*Fight (**F X**)*	Assaults conspecific
*Assaulted (**ASS b X**)*	Is assaulted by conspecific
*Jump on (**JM**)*	Attack suddenly and forcefully jump on the back of conspecific
*Paw (**PW**)*	Strike with the paw someone else
*Flehmen (**FH**)*	Sniffs, then lift head with open mouth, breath in, eyes almost closed and upper lip curled
*Head butt (**HB X**)*	Briefly pushes/bumps its head against a conspecific's head
*Head butted (**HB b X**)*	Has is head briefly bumped by a conspecific's head
*Scratch (**SRT**)*	Damage and mark the surface of by scraping with nails
*Lick object (**LO**)*	Protrudes tongue from the mouth and strokes object with it
*Lick lips (**LL**)*	Protrudes tongue from the mount and lick lips
*Pace (**PC**)*	Repetitive locomotion in a fixed pattern.
*Head shake (**HSH**)*	Repetitive move of the head with short and quick movements
*Circling (**CIR**)*	Repetitive locomotion in a circle around
*Twitch (**TW**)*	Moving with a sudden, quick and short movements as reaction to something/someone
*Move backwards (**MB b X**)*	Moving backwards with ears backwards and head down as reaction to someone
*Play object (**PLO**)*	Interacts with objects
*Play with conspecific (**PL X a**)*	Initiates interaction with conspecific in a non-harmful manner (chasing, jumping, wrestling, etc.) and gets no response
*Play with conspecific and is reciprocated (**PL X**)*	Initiates interaction with conspecific in a non-harmful manner (chasing, jumping, wrestling, etc.) and gets some response
*Played by conspecific (**PL X p**)*	Passive receiver of conspecific play
*Roll (**RO**)*	Lying on the ground, the animal rotates its body from side to side. During the roll, the back is rubbed against ground, the belly is exposed and all paws are in the air
*Rub – Body (**RB**)*	Rubs body on conspecific or object
*Rub – Head (**RH**)*	Rubs head on conspecific or object
*Rubbed (**RBD**)*	Rubbed by a conspecific
*Self-groom (**SG**)*	Licks own fur

Event Behaviour	**Description**
*Sniff (**SNF**)*	Smells by inhaling air through the nose
*Spray (**SP**)*	Stands with tail raised vertically and releases a jet of urine backwards against a vertical surface or object.
*Stalk (**STL**)*	Usually slow, forward locomotion with back and head slightly lowered and eyes focused on the stalked individual/object.
*Stare (**STR**)*	Looks fixedly to something/someone
*Tail up (**TU**)*	Tail is held vertically, in a upright position
*Tail slash (**TS**)*	Standing or moving with tail bent over body, slashing.
*Tail tip (**TT**)*	Prolonged, repeated movement of tip of the tail.
*Tail twitch (**T TW**)*	A rapid flick of the tail in either a side to side or up to down motion
*Urinate (**U**)*	Releases urine, standing or squatting
Vocalization	Produces sounds or calls with is mouth/throat
*Vocalization – Chuff (**CHF**)*	Cat expels jets of air through the nose creating a low-intensity, soft, pulsed sound, described as being similar to the snorting of a horse
*Vocalization – Grunt/Cough (**GRT**)*	Short, throaty call, characterized by the deep contraction and expansion of the diaphragm
*Vocalization – Growl (**GRL**)*	A low-pitched, throaty, rumbling noise produced while the mouth is closed.
*Vocalization – Hiss (**HS**)*	A drawn-out, low-intensity hissing sound produced by rapid expulsion of air from the cat's mouth, usually during exhalation.
*Vocalization – Roar (**RO**)*	Long, throaty, high intensity call
*Vocalization – Syndetic call (**SC**)*	Amiable call with the purpose of gather or appease conspecifics
*Walk (**WK**)*	Forward locomotion at a slow gait
*Run (**RU**)*	Forward locomotion at a quick gait
*Warning bite (**W BT X**)*	Snap teeth in response to an unwelcomed closing individual.
*Yawn (**YN**)*	The mouth is opened widely, the head tips back, lips are pulled back so that the teeth are exposed
*Look Around (**LOA**)*	Turn one's eyes toward something or in some direction in order to see
*Crouch (**CR**)*	Bend close to the ground or stoop low for lay down
*Crouch for other lion (**CR X**)*	Stoop low and lays down on the sternum with ears backwards, head down or open mouth for submit to someone
*Dive in (**DIN**)*	Plunge into water and stay in the water
<u>Breeding behaviours</u>	
*Mount (**MT**)*	Moves on top of conspecific in the attempt of copulate
*Nape bite (**N BT**)*	The male performs an inhibited nape bite, where he will place his mouth on or around the back of the female's neck at the moment of, or just after, ejaculation, but is unlikely to actually bite down.
*Being mounted (**BM**)*	Is mounted by other lion
*Sniff anogenital (**SNA**)*	Smells the anogenital region of conspecific

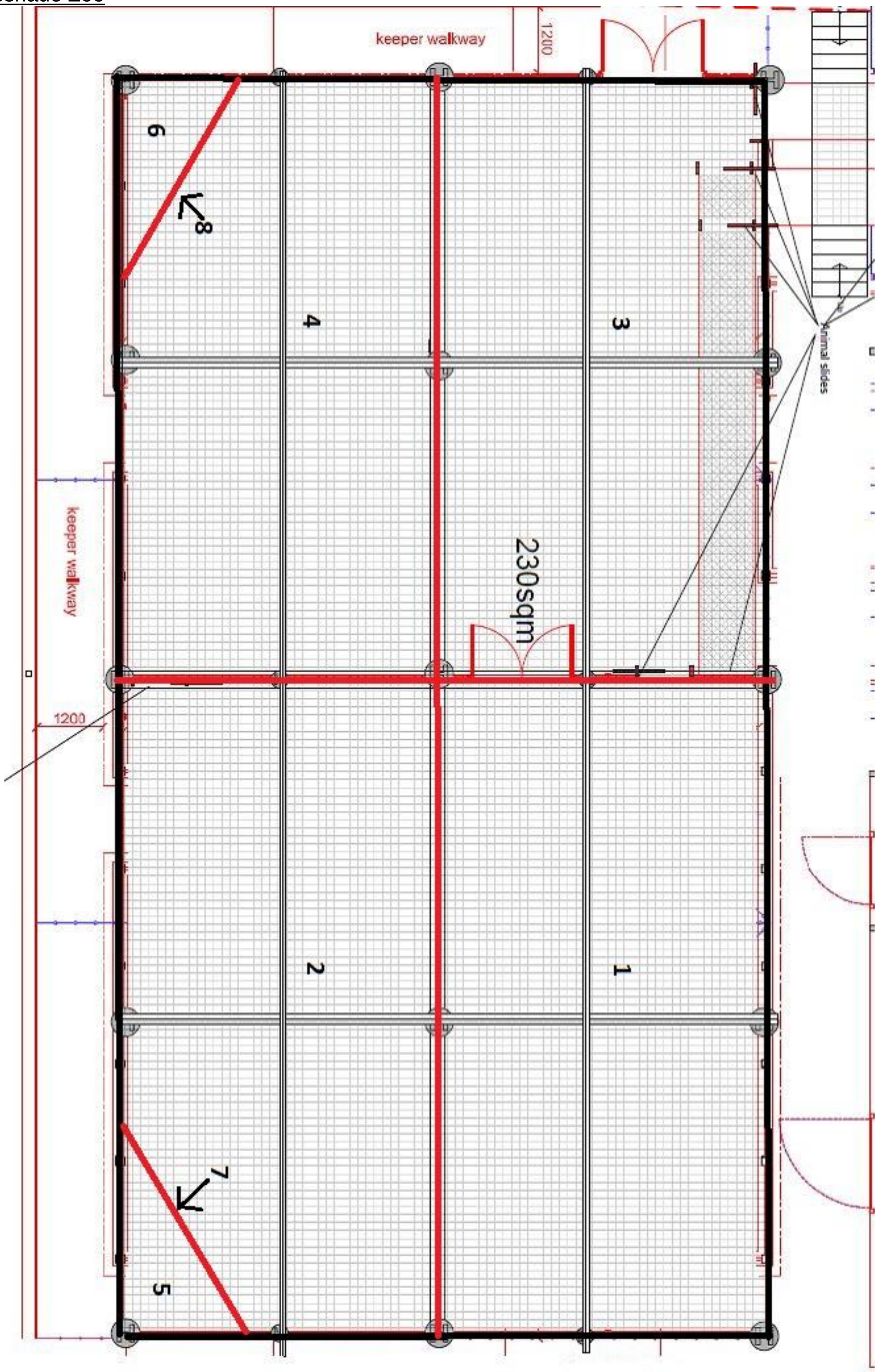
APPENDIX 2: Enclosure Map and Zone Descriptions

London Zoo



Zone	Features	Approx. % of Total Section Area
	Females' Section: Area = 1395 m^2	
1	Back right corner of enclosure; next to entrance to indoor area; borders raised walkway along back wall	4.85
2	Front right corner; contains chain-link fence next to public walkway	4.85
3	Borders raised walkway along back wall; next to entrance to indoor area	3.88
4	Surrounds wooden platform	4.85
5	Borders raised walkway along back wall; includes metal gate to male's section of the enclosure	3.88
6	Front left corner of original area of enclosure; contains small covered area under rock wall	3.88
7-10	Located indoors	N/A
11	Lower level of wooden platform	1.46
12	Mid-level of wooden platform; often used to climb up to Zone 13	0.97
13	Top level of the wooden platform; offers high viewpoint	1.46
14	Top of a concrete slab in front of the entrance to indoor area	1.46
15	Area underneath Zone 14	1.46
16	Grass-covered platform in front of Zone 6; overlooks moat	0.97
17	Located under Zone 16	0.97
18	Thin zone bordering edge of moat	8.74
19	Start of new area of enclosure; contains rocky ledge along back wall	6.80
20	Covers right side of the 360 area; right side looks over the moat	4.85
21	Contains section of trees and bushes	17.48
22	Covers left side of 360 area	8.74
23	Back left corner of new area of enclosure	4.85
24	Allows access to Zone 25	8.74
25	Covered area containing heated platforms ("Hot rocks"); where training occurs	4.85
	Male's Section: Area = 800 m^2	
26	Faces access area where staff often walk; where outdoor training occurs	15.09
27	Contains access door for indoor area	9.43
28	Also faces access area where staff walk; contains part of small hill in middle of enclosure	20.75
29	Contains old train car/boxes; borders raised walkway	26.42
30	Borders mongoose enclosure	13.21
31	Contains train car where feeding sometimes occurs; allows access to train station platform with large public viewing windows	15.09

Whipsnade Zoo



Zone	Features	% of Total Area
	Area = 230 m^2	
1	Back right corner; away from walkways	24.24
2	Front right corner; contains sleeping platform; walkway along front edge	22.73
3	Back left corner; walkway bordering side edge	24.24
4	Front left corner; walkway along front and side edges; contains training platform	22.73
5	Sleeping platform	1.52
6	Training platform	1.52
7	Area underneath sleeping platform	1.52
8	Area underneath training platform	1.52

APPENDIX 3: Personality Questionnaire

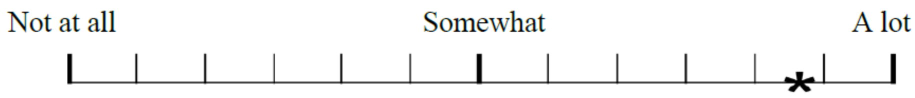
RATING INDIVIDUAL ASIATIC LIONS

Procedure:
Please rate each individual on the continuous scale provided for each adjective (31 adjectives). The names of the individuals are all listed on one sheet per adjective to allow you to evaluate each individual relative to the others. Please do not discuss your answers with anyone else.

EXAMPLE:

ACTIVE
Moves around enclosure (e.g. paces, runs, stalks)

Individual X



A separate comment sheet is provided to allow you to add information not covered by the adjectives for each individual. Please include any additional adjectives you can think of in your comments. Comments should also include how each individual usually reacts to you specifically.

Please provide the following information about yourself below:

Name (optional): Date:

Sex: F M

Number of years worked with lions overall:
Number of years worked with lions at this institution:
Number of years worked with the current group of lions:
Average number of hours per week spent with the lions:
Do you routinely enter the enclosure with the lions?
Number of years worked with animals in general: Do you particularly like lions or cats in general? (e.g. Are you a “dog” or a “cat” person?)
Do you believe that there are distinct personalities among your lions? Do you feel that certain personality differences could be correlated with reproductive success? Disease? How the individual copes with stress?

ACTIVE

Moves around enclosure (e.g. walks, patrols the enclosure, runs, stalks)

Rubi

Not at all Somewhat A lot

Indi

Not at all Somewhat A lot

Heidi

Not at all Somewhat A lot

AGGRESSIVE TO CONSPECIFICS

Reacts hostile (e.g. attacks, growls) toward other lions

Rubi

Never Sometimes Always

Indi

Never Sometimes Always

Heidi

Never Sometimes Always

AGGRESSIVE TO FAMILIAR PEOPLE

Reacts hostile and threatening towards familiar people and staff members

Rubi

Never Sometimes Always

Indi

Never Sometimes Always

Heidi

Never Sometimes Always

AGGRESSIVE TO UNFAMILIAR PEOPLE

Reacts hostile and threatening towards unfamiliar staff and members of the public

Rubi

Never Sometimes Always

Indi

Never Sometimes Always

Heidi

Never Sometimes Always

CALM

Not easily disturbed by changes in the environment

Rubi

Easily disturbed Never disturbed

Indi

Easily disturbed Never disturbed

Heidi

Easily disturbed Never disturbed

CURIOUS

Approaches and explores changes in the environment (e.g. enriching and novel objects)

Rubi

Never Sometimes Always

Indi

Never Sometimes Always

Heidi

Never Sometimes Always

ECCENTRIC
Shows stereotypic or unusual behaviours

Rubi Never Sometimes Always

Indi Never Sometimes Always

Heidi Never Sometimes Always

EXCITABLE
Overreacts to changes in the environment

Rubi Never Sometimes Always

Indi Never Sometimes Always

Heidi Never Sometimes Always

FRIENDLY TO CONSPECIFICS
Initiates and seems to seek proximity to other lions

Rubi Never Sometimes Always

Indi Never Sometimes Always

Heidi Never Sometimes Always

FRIENDLY TO KEEPERS

Initiates proximity with keepers; approaches fence readily and in a friendly manner (e.g. vocalises, rubs on fence)

Rubi

Never Sometimes Always

Indi

Never Sometimes Always

Heidi

Never Sometimes Always

FRIENDLY TO FAMILIAR PEOPLE

Initiates proximity with familiar visitors; approaches fence readily and in a friendly manner (e.g. vocalises, rubs on fence)

Rubi

Never Sometimes Always

Indi

Never Sometimes Always

Heidi

Never Sometimes Always

FRIENDLY TO UNFAMILIAR PEOPLE

Initiates proximity with unfamiliar visitors (adults, kids, male, females); approaches fence readily and in a friendly manner (e.g. vocalises, rubs on fence)

Rubi

Never Sometimes Always

Indi

Never Sometimes Always

Heidi

Never Sometimes Always

FEARFUL OF CONSPECIFICS

Retreats and hides from other lions

Rubi Never | Sometimes | Readily

Indi Never | Sometimes | Readily

Heidi Never | Sometimes | Readily

FEARFUL OF FAMILIAR PEOPLE

Retreats and hides from familiar people and staff members

Rubi Never | Sometimes | Readily

Indi Never | Sometimes | Readily

Heidi Never | Sometimes | Readily

FEARFUL OF UNFAMILIAR PEOPLE

Retreats and hides from unfamiliar staff and members of the public

Rubi Never | Sometimes | Readily

Indi Never | Sometimes | Readily

Heidi Never | Sometimes | Readily

INSECURE

Seems scared easily; "jumpy" and fearful in general

Rubi Never Sometimes Always

Indi Never Sometimes Always

Heidi Never Sometimes Always

PLAYFUL

Initiates and engages in play behaviour (seemingly meaningless, non-aggressive behaviour) with objects and/or other lions

Rubi Never Sometimes Always

Indi Never Sometimes Always

Heidi Never Sometimes Always

SELF-ASSURED

Moves in a seemingly confident, well-co-ordinated and relaxed manner

Rubi Never Sometimes Always

Indi Never Sometimes Always

Heidi Never Sometimes Always

SMART

Learn quickly to associate certain events and appears to remember for a long time

Rubi Never Sometimes Always

Indi Never Sometimes Always

Heidi Never Sometimes Always

SOLITARY

Spends time alone; avoids company

Rubi Never Sometimes Always

Indi Never Sometimes Always

Heidi Never Sometimes Always

TENSE

Shows restraint in movement and posture

Rubi Never Sometimes Always

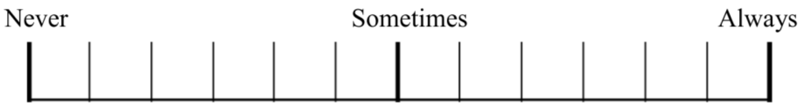
Indi Never Sometimes Always

Heidi Never Sometimes Always

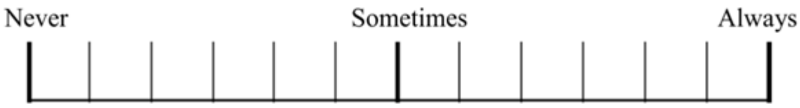
VOCAL

Frequently and readily vocalizes

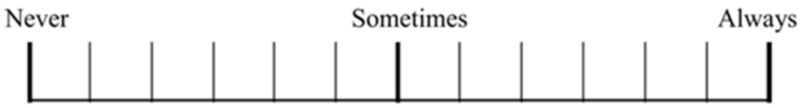
Rubi



Indi



Heidi



COMMENTS:

Rubi:

Indi:

Heidi:

Adapted from Chadwick (2014)