Department of Comparative Cognition
Veterinary University Vienna

Domestication Lab (Head: Friederike Range)

„Does the Noise Level and Number of Visitors Influence Dogs and Wolves' Behavior?"

Masterthesis

Veterinary University Vienna

Submitted by

Hannah Kanwischer

Vienna, June 2022

Supervised by:

Cimarelli, Giulia PhD;

Range, Friederike Ass. Prof. Dr

Statement

I hereby declare that this thesis was conducted only with the named literature and resources. All work was done by myself, and the work of others is marked as such. Further, the present study was written by myself, and was not published anywhere else.

Vienna, 07.06.2022

Hannah Kanwischer

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Abstract

The visitor effect has already been investigated with many different animal species. The goal of these studies is to understand if, and how, visitors influence animals living in captivity. However, to date only few studies have focused on canines, and none have compared equally raised dogs, *C. l. familiaris*, and wolves, *Canis lupus*. This direct comparison might give valuable insights on how domestication has changed the perception of humans by dogs and wolves. Here, we observed the animals at the Wolf Science Center (WSC) in their reactions to spontaneously behaving human visitors, and their pet dogs. Following the 'Hyper-Sociability Hypothesis, we expected dogs to show less negative behavior in reaction to the visitors, compared to wolves. While we found that visitor number itself had no influence on the animals, we could find a significant effect for visitor noise levels, as well as certain visitor behaviors. However, contrary to our hypothesis, we could not find an overall negative visitor effect on neither of the animals, which might be best explained by the extensive socialization of the animals from puppyhood on.

Kurzzusammenfassung

Der Besucher-Effekt wurde bereits anhand vieler verschiedener Tierarten untersucht, um zu verstehen ob und wie Besucher*innen Tiere die in Zoos, und ähnlichen Einrichtungen leben, beeinflussen. Bis heute haben sich jedoch nur wenige Studien mit der Familie der *Kaniden* befasst, und keine hat identisch aufgezogen Hunde, *C. l. familiaris,* und Wölfe, *Canis lupus,* verglichen. Dieser direkte Vergleich kann wertvolle Hinweise geben, wie sich im Laufe der Domestikation die Wahrnehmung bezüglich des Menschen vom Wolf zum Hund verändert hat. In dieser Studie haben wir die Tiere des Wolf Science Center (WSC) in ihren Reaktionen auf sich spontan verhaltene Menschen und ihre privaten Hunde beobachtet. Gemäß der 'Hyper-Sociability Hypothesis' erwarteten wir, dass Hunde, im Vergleich zu Wölfen, weniger negatives Verhalten als Reaktion auf die Besucher*innen zeigen würden. Während die Besucher*innen Zahl keinen Einfluss auf die Tiere zu haben scheint, konnten wir einen signifikanten Einfluss des Geräuschpegels, sowie einiger Besucher*innen Verhaltensweisen nachweisen. Entgegen unserer Hypothese konnten wir jedoch einen allgemeinen negativen Besucher*innen Effekt auf die Tiere feststellen, was am wahrscheinlichsten mit der extensiven Sozialisierung der Tiere von klein auf erklärbar ist.

Abbreviations

WSC	Wolf Science Center
LAeq	Overall noise level (in dB)
LAmax	Maximum sound level (in dB)

1. Introduction

The dog (*Canis lupus familiaris*) was the earliest domesticated species (Druzhkova et al., 2013; Germonpré et al., 2009; Wang et al., 2013), with the domestication process leading to a diverging evolution between dogs and their wild counterpart, the wolf (*Canis lupus*). A series of ecological, behavioral, and cognitive elements differ between the two species (Marshall-Pescini et al., 2017a), which also appear in free-living populations (i.e., free-ranging dogs and wild wolves). In fact, free-ranging dogs live in and around human settlements, mostly sustained by scavenging on human refuse (Marshall-Pescini et al., 2017; Sen Majumder et al., 2016). Wolves, on the other hand, live distant from humans (Musiani et al., 2010), and show fearful responses towards them (Musiani et al., 2010). However, from the behavior of free-ranging canines alone, we cannot conclude to what extent dogs' tendencies to interact with humans are inherently different from those of wolves. Dog puppies raised in human settlements are socialized to humans, while wolf puppies raised in the wilderness likely never see humans in their early life. Thus, socialization during critical development stages constitutes a confounding factor (for the influence of socialization see also Wirobski et al., 2021).

One of the most prominent behavioral differences is how they relate to humans: in fact, dogs gaze more at humans (Bentosela et al., 2016; Gácsi et al. 2005; Miklósi et al., 2003), spend more time in closer proximity (Lazzaroni et al., 2020), and approach humans faster, compared to wolves (Bentosela et al., 2016). Additionally, dogs do seem to have a reduced flight distance when approached by humans, compared to wolves (Hare & Tomasello, 2005; Scott & Fuller, 1965), and a potentially stronger tendency to interact with humans (Gácsi et al., 2005; Range et al., 2019; vonHoldt et al., 2017). Importantly, only a comparison conducted between animals living under the same environmental conditions would allow us to differentiate potential effects of domestication from that of socialization. Research programs investigating changes in interspecific social behaviors, as a result of domestication, need to minimize experience and environmental differences when raising dogs and wolves. They do so by rearing and keeping both species in the same standardized manner (Miklósi et al., 2003; Range & Virányi, 2014). Such a set-up enables a direct comparison of both species, creating reliable information about how domestication affected dogs' social behavior towards humans. Results from comparisons between equally socialized dogs and wolves (i.e., hand-raised, hence well socialized to humans; Miklósi et al., 2003; Range & Virányi, 2014) show that dogs seek out human contact while wolves tend to be less interested in humans (Bentosela et al., 2016; Gácsi et al., 2005; Lazzaroni et al., 2020; Wirobski et al., 2021). It has been suggested that during early domestication these changes in behavior, of dogs being more socially attentive and drawn to humans, were an incidental by-product of the selection against fear and aggression towards humans. Indeed, in a study comparing equally hand-raised dogs and wolves in a choice task between two familiar humans, providing affiliative interactions or a food reward in the pre-test phase, wolves overall approached the experimenters less than dogs (Lazzaroni et al., 2020). While both dogs and wolves seem to be able to form trustful relationships with bonded humans, dogs still seem to spend more time with humans in general (Wirobski et al., 2021), and wolves are more neophobic towards humans (for a review see Range & Marshall-Pescini, 2022). Hence, dogs seem to be more attracted to humans than wolves. Such species-specific differences already emerge at an early age. Indeed, a comparison between dog- and wolf-pups at the age of 3-, 4- and 5-weeks in human-preference tests, where the animals were given the choice to choose between their caregiver and other objects (nursing bottle, unfamiliar adult dog, unfamiliar experimenter, and familiar conspecific age mate), revealed that the dog pups not only preferred the caregiver over the other objects in more tests than the wolf pups, but they also displayed more communicative signals and less aggression towards the familiar experimenter (Gácsi et al., 2005).

These findings align with the ‘Hyper Sociability Hypothesis’, stating that domestication may have led to genetic changes resulting in higher sociability in dogs, manifesting in higher attraction towards humans than wolves (Bentosela et al., 2016; vonHoldt, 2017). Such behavioral differences between dogs and wolves seem to be linked to genetic differences in certain genes on chromosome 6, supposedly contributing to higher sociability in dogs towards humans compared to wolves (vonHoldt, 2017). Therefore, domestication seems to have changed how dogs differ from wolves on a phenotypic level thanks to changes at the genetic level.

Nevertheless, most evidence reporting differences between dogs and wolves interacting with humans derives from studies using experimental settings. In these studies, the experimenter was familiar to the subjects and, even if unfamiliar, their behavior was standardized, hence not representative of spontaneous interactions. Nevertheless, when debating such questions on how animals react to humans based on human behavior itself, rather than predefined test conditions, using unfamiliar humans performing unstandardized behavior is crucial. One way to test how dogs and wolves react differently to the presence and un-standardized behavior of unfamiliar humans is to conduct observations of spontaneous behaviors (for both the human and the animal side). A captive setting, such as a zoo or research facility with public access, offers this opportunity, as animals are exposed to visitor presence and their spontaneous behavior. However, to date, only few studies have investigated canines' reactions to the presence and behavior of visitors, and none has directly compared dogs and wolves. In a study on a subspecies of wolves, researchers compared the behavioral and fecal cortisol response of four Mexican wolf packs (*Canis lupus baileyi*) housed at three Mexican zoos (Pifarré et al., 2012). These wolves ate and rested less and showed a higher cortisol response during busier weekends compared to less frequented weekdays, suggesting an impact of human presence on animal welfare (Pifarré et al. 2012). Similar results were found by Schultz and Young (2018) in their study on captive coyotes (*Canis latrans*): coyotes were less active and showed higher avoidance of open areas with human activity. While Pifarré et al. (2012)s' study was conducted at zoos with high visitor density, Schultz and Youngs' (2018) study was conducted at a research facility with minimal human contact. Despite different socialization with humans, visitor presence seemed to be stressful for both canine species within these settings (Coyotes: Schultz & Young (2018) and Mexican wolf: Pifarré et al., 2012). These results potentially support the hypothesis that wild canines respond to the presence of unfamiliar humans with negatively valanced emotional states (e.g., fear and more vigilant behavior). However, in such studies it was not clear whether the mere presence or absence of humans, their number, or behavior negatively affected the animals. Only in one recent study, a binary operationalization of visitor variables (i.e., presence vs. absence) was compared to more detailed visitor behaviors (i.e., noise, Boyle et al. (2020)). Wolves' alert behavior did not differ between the two conditions (presence vs. absence of visitors) but increased significantly when considering visitor noise as the independent variable. This suggests that visitor presence *per se* might be less relevant for wolves than visitor noise levels (Boyle et al., 2020). This also holds true for dogs, as Hewison et al. (2014) revealed that dogs show signs of improved welfare on days when visitor access to kennels, hence the noise level, was restricted, compared to days with regular visitor activity. However, for the study by Hewison et al. (2014) again only the visitor noise was measured, not taking other variables in consideration. Therefore, dogs might as well be stressed by the presence of unfamiliar humans, but it remains unclear how they compare to wolves, as there has been no direct comparison yet. Noise level might be the result of either the number of people present, and how much and how loud they talk to each other, or other spontaneous behavior (e.g., animal-directed behaviors) that might have a direct impact on canine behavior as it has been observed in other species (see Boyle et al., 2020; Choo et al., 2011; Davey, 2006; Roth & Cords, 2020; Sherwen & Hemsworth, 2019). Indeed, previous studies indicate a necessity of collecting more detailed visitor variables, as different behaviors (such as looking at the animals or photographing them) might be of different valence to animals belonging to different species (Choo et al., 2011; Roth & Cords, 2020). Such detailed analysis of visitors' behavioral variables could be used to understand whether and how dogs and wolves react to spontaneous human behavior. Unfortunately, so far, the only direct species comparison of dogs' and wolves' reactions to visitors lacked a detailed analysis of visitor variables. A master thesis conducted at the Wolf Science Center (WSC), where both dogs and wolves are reared and kept in an identical manner (Range & Virányi, 2014), investigated the circadian and circannual activity patterns of dogs and wolves in relation to familiar humans, controlling for the presence (but not the behavior) of unfamiliar humans (i.e., park visitors). Neither dogs, nor wolves seemed to be influenced by the presence of visitors (master thesis Wacker, 2020). Yet, as demonstrated by Boyle et al. (2020) this binary dimension may not be precise enough to detect possible influences.

To investigate species-specific differences in dogs' and wolves' responses to unfamiliar humans, we adopted the framework provided by Sherwen and Hemsworth (2019). The authors identify three factors to consider. Due to the uniqueness of animal exhibits, studies should: (a) control for physical enclosure characteristics (e.g. climate in outdoor exhibits) and only compare species living in a comparable captive environment; (b) conduct a precise analysis of visitor variables as they might reveal more fine-scaled effects than simply taking into account the overall presence of visitors; and (c) compare closely related species whose behaviors are the same To date, no studies comparing dogs and wolves have controlled for these elements all together. The WSC offers a unique opportunity to follow Sherwen and Hemsworths' (2019) recommendations, as (a) the environmental characteristics are the same for both dogs and wolves; (b) both visitors' (and animals') spontaneous behaviors are easily observable; and (c) dogs and wolves show the same behavioral patterns indicative of positive or negative perception of human presence (see Hosey, 2008; e.g. stress- and fear-related behaviors, for canines: see; intraspecific agonistic behaviors, see Chamove et al., 1988; Riggio et al., 2019; Roth & Cords, 2020; and intraspecific affiliative behaviors, see Chamove et al., 1988; Riggio et al., 2019).

1.1 Hypothesis and Predictions

The current study compares the reactions of dogs and wolves living under the same environmental conditions to unfamiliar human (i.e., visitors) presence, noise levels and spontaneous behavior. We aim to answer the following research questions: did domestication change how dogs react to the noise level and presence of spontaneously behaving, unfamiliar humans in comparison to wolves? And which human behaviors have a stronger impact on dogs and wolves' reaction?

The 'Hyper Sociability Hypothesis' proposes that domestication resulted in genetic changes promoting higher sociability in dogs, manifesting in higher attraction towards humans, higher dependence, and higher contact-seeking of dogs towards humans compared to wolves (Bentosela et al., 2016; vonHoldt, 2017). Based on this, we hypothesized that dogs are not negatively impacted by the presence and behavior of visitors. Despite both being hand-raised and kept in a comparable manner (Range & Virányi, 2014), we expected wolves to be more negatively impacted by the presence and behavior of visitors than dogs. We predicted that wolves would display more behaviors indicative of negative visitor perception compared to dogs (e.g., an increase in stress-related behaviors, a reduction in social interactions with pack members) in response to visitor noise level, visitor number, and behaviors.

2. Materials and Methods

2.1. Subjects

The subjects were 13 wolves (*Canis lupus,* living in N=6 packs), and 6 mongrel dogs (*Canis lupus familiaris*, living in N=3 packs), housed at the Wolf Science Center in Ernstbrunn, Austria (see Table 1). The wolves were born in captivity, and the dogs are from Hungarian shelters (Layla and Zuri) or were born at the WSC. Dogs and wolves were hand-raised by humans in a standardized way and are kept under comparable conditions (Range & Virányi, 2014). As part of animals' regular routine, packs are regularly shifted between different enclosures by the staff through tunnels or by leash, depending on their need in study participation or training. Hence, different packs were observed in different enclosures over the course of the study.

Table 1: Subjects, listed with age, sex, species and belonging pack members and pack name.

Subject	**Age**	**Sex**	**Species**	**Pack with**	**Pack Name**
Yukon	12	female	*Canis lupus*	Geronimo & Wamblee	Geros
Tala	9	female	*Canis lupus*	Chitto	Talitto
Una	9	female	*Canis lupus*	Nanuk	Nanuna
Taima	5	female	*Canis lupus*	Tekoa	T'n'T
Geronimo	12	male	*Canis lupus*	Wamblee & Yukon	Geros
Nanuk	12	male	*Canis lupus*	Una	Nanuna
Kenai	11	male	*Canis lupus*	Amarok	Kenrok
Amarok	9	male	*Canis lupus*	Kenai	Kenrok
Chitto	9	male	*Canis lupus*	Tala	Talitto
Wamblee	9	male	*Canis lupus*	Geronimo & Yukon	Geros
Etu	5	male	*Canis lupus*	Maikan	Maitu
Maikan	5	male	*Canis lupus*	Etu	Maitu
Tekoa	5	male	*Canis lupus*	Taima	T'n'T
Layla	10	female	*Canis familiaris*	Panya	DumDum

Zuri	10	female	*Canis familiaris*	Enzi	Zuzi
Imara	7	female	*Canis familiaris*	Hiari	Hiara
Panya	7	female	*Canis familiaris*	Layla	DumDum
Enzi	7	male	*Canis familiaris*	Zuri	Zuzi
Hiari	7	male	*Canis familiaris*	Imara	Hiara

2.2. Study Setting

In total, six enclosures were visible to the visitors for the wolves and one for the dogs. All enclosures were built in a comparable manner with water dispensers and huts for shelter for all animals. Additionally, the dog enclosure provides a house for further protection. Each enclosure is delimitated by a high metal wire, as well as a wooden barrier with at least one meter distance to the fence, to allow enough distance between the animals and the area accessible to the visitors. All enclosures are vegetated with trees and more covering bushes, allowing the animals to choose between being visible to the visitor or not. Their size ranges from 1.923m^2 for the smallest enclosure (enclosure 6) to 10.364m^2 for the largest (enclosure 9b, see Figure 1). The experimenters' observation areas (see Figure 1) were predefined and stayed the same throughout the data collection. These areas were chosen because of the high visitor passage and their positioning in having the highest chances to view the animals.

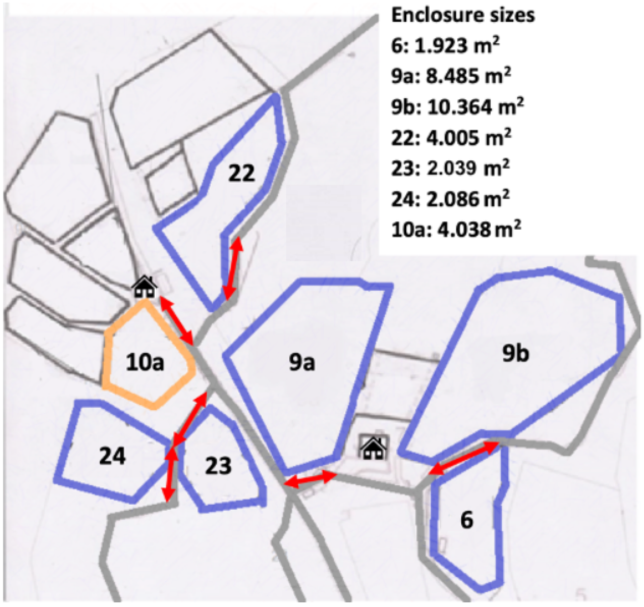

Figure 1: Map of the WSC with enclosure sizes in m^2. The wolf enclosures are framed in blue while the one visible dog enclosure is framed in orange (10a). Non-framed enclosures were not visible to the visitors. The red arrows mark the observation areas. The lower house is the trainer house while the upper one is the doghouse.

2.3. Observation Protocol

No interventions were applied to the animals, rather spontaneous behaviors were observed during their daily life when in their home enclosures and with their pack members. All animals have been habituated to researchers observing them in their home enclosures, as regular observations have been carried out since puppyhood. Behavioral observations for the present project were conducted over twenty-seven non-consecutive days. They took place on Monday, Thursday, Friday, and Sunday from 9am-5pm, during the park opening times. As the park is closed on Monday (i.e., visitors are absent) this day acted as a control condition. Thursday and Friday represented regular weekdays with a limited number of visitors, while it was expected that most visitors would visit the park on Sundays (Chiapero et al., 2021).

Each pack was observed at different times over the day in a semi-randomized manner, so that over the course of the study each part of the day was equally represented in the final sample for each animal (Appendix, Table 10+11). During data collection continuous sampling and instantaneous scan sampling with 30 one-minute intervals were used (Martin & Bateson, 2007). Two observers positioned themselves at a point next to the enclosure from where they could easily observe both the pack and visitors. The observers collected the data directly into an Excel spreadsheet using a tablet (SAMSUNG, Tab Active2, SM-T395). Before each observation session started, the temperature, enclosure and weather condition were noted. After a five-minute habituation period to the presence of the observers, the observation commenced. The recorded behaviors were based on existing ethograms (see Dale, Marshall-Pescini, et al., 2017; Dale, Range, et al., 2017; master thesis, Wacker 2020; Mariti et al., 2012; Pastore et al., 2011; Pifarré et al., 2012; Roth & Cords, 2020, see Table 2). The final ethogram included 'Visibility' of the animals, 'Basic Behaviors' (eating/drinking, defecation and vocalizing; based on existing ethograms see Dale, Marshall-Pescini, et al., 2017; Dale, Range, et al., 2017; master thesis, Wacker 2020), 'Social Behaviors' (affiliative (e.g. play bow, greeting) and agonistic behaviors (e.g. aggressive, dominant and submissive), towards a pack-member or pet-dogs on the visitor pathways; see Dale, Marshall-Pescini, et al., 2017; Dale, Range, et al., 2017). Moreover, we collected 'Stress-related' behaviors (autogrooming, yawning, body shaking, lip licking and scratching; see Mariti et al., 2012; Pastore et al., 2011; Pifarré et al., 2012; Roth & Cords, 2020). As all these behaviors are usually brief, they were observed continuously and collected as all occurrences of such behavior for each one-minute observation interval. Further, every minute, we recorded the 'Locomotion' state (i.e., sleeping, immobile lying/standing or moving) of each individual and the 'Proximity' (1 = together, 2 = 1 body length, 3 = 3 body length, 4 = alone) between the animals for each individual of the pack. The main observers' positioning in the observation area was slightly adjusted to improve visibility if the animals were moving.

Visitor behavior was collected by a second, stationary observer with scan-sampling in a predefined observation area (area along the visiting path with the highest expected visitor traffic due to the highest chance of seeing the animals at that point, same as for the animal observations). As highlighted by Sherwen & Hemsworth (2019), visitors and animals might interfere with each other which is why in this study visitor variables from the second observer were implemented. Moreover, while in most zoos pet-dogs are not allowed, this is not true for the WSC. The presence, number (collected as 0 = no dog, 1 = one dog, and 2 = two or more dogs) and locomotive state (stationary or moving) of visitors' pet dogs were collected, as anecdotally they do change the behavior of the animals hosted at the WSC. The collected variables were chosen due to their relevance shown in previous studies: i.e., a second observer collected the number of visitors, as these have been shown to influence animals in their activity level and behavior (i.e. Boyle et al., 2020; Pifarré et al., 2012). Moreover, we recorded the noise level (recorded using a sound meter level app (EA LAB "NIOSH", Version 1.2.4.60) on an iPhone 11), as this was found to influence animal behavior in multiple studies (i.e. Birke, 2002; Boyle et al., 2020; Hewison et al., 2014; Larsen et al., 2014). For the present study, we recorded the overall noise level (LAeq in dB) and the maximum sound level (LAmax in dB) during a five-minute interval respectively. The App recorded the LAeq and the LAmax automatically after being started and was stopped every five minutes by the second observer, resulting in six five-minute intervals for one 30-minute observation period. The sound recording was operated by the second observer, due to her stationary position, as the moving sound of the main observer would have distorted the recording. For the maximum noise level (LAmax), we afterwards excluded the data points where either the observer themselves, or the observed animals were the producers of the loudest noises (e.g., barking). To test whether visitors' spontaneous behaviors affect the animals, we differentiated between behaviors that could draw the animals' attention ("animal directed": a sum of pointing, taking pictures, luring, and making animal noises) and those that could potentially be a nuisance to them, or were against park rules ("unruly": a sum of feeding, shouting, object throwing and dog- and human trespassing; based on (master thesis Brandl, 2016; Choo et al., 2011). Because unruly behavior violated the park rules, if these behaviors were observed, the two observers had to interfere and make the visitors verbally aware. As this potentially altered the visitors' behavior, the minute after the reprimand was excluded from the analysis. To control for animals behaving differently when familiar humans were present (i.e., trainer and interns), we also collected the presence of familiar humans (collected as 'staff').

*Table 2: Behaviors marked with * were identified in Piffaré et. (2012) as correlating with the physiological stress response in Mexican wolves. The human behaviors listed were collected by a second observer.*

Behavioral variable	**Definition**
Visibility	
Visibility	Animal visible or not
Basic Behaviors	
Eating/Drinking*	Swallowing food/water provided or caught
Defecate	Releasing feces/urine
Vocalizing	Howling, barking, whining
Autogrooming	Self-grooming by the animal
Vocalizing	Howling, barking, whining
Social Behaviors	
Affiliative behavior	Grooming, body contact, bow, social play, lie friendly, stand friendly, body rub, nose-to-nose
Agonistic aggressive behavior	Ignore, growl, stare, bark, bare teeth, open mouth & bare teeth, raising hackles, jaw spar, snapping, point, lunge, attack, knock down, pin, bite, fight, chase
Agonistic dominant behavior	Stand tall, stand over, paws on, ride up, head on, muzzle bite

Agonistic submissive behavior	Avert gaze, head dip, flattening ears, tail dip, crouch, flee, belly exposure, withdrawing, avoidance
Stress related	
Autogrooming	Self-grooming by the animal
Yawning	Air inhalation with open mouth and pushed back chaps, eyes slightly closed
Body shaking	Moving backwards and forwards or up and down in quick, short movements
Lip Licking	Tongue touching the lips
Scratching	Rubbing the own body with the claws or other objects
Locomotion	
Immobile standing*	Immobile, remaining at the same place in a standing position
Immobile lying*	Immobile, remaining at the same place in a standing position
Sleeping*	Lay down with head on the ground and eyes closed
Moving*	Walking, Trotting, Cantering, Hunting
Proximity	
Proximity	Distance between the animals
Human Behaviors	
Noise Level	A weighted maximum sound level
Stationary Dogs	Number of stationary pet dogs within the observation area at the beginning of the 1min observation interval
Moving Dogs	Number of moving pet dogs within the observation area at the beginning of the 1min observation interval
Unruly Behavior	Sum of feeding, shouting, throw object, dog- and human trespassing
Animal Directed Behavior	Sum of lure (visitors show behaviors to gain the animals' attentions, e.g., calling), picture (visitor takes image material of the animals), pointing, animal noise
Staff	Sum of trainer and student

Overall, animals were observed for 137.5h, of which 45.25h were spent observing the dogs (see Table 3) and 92.25h monitoring the wolves, for an average of 15h per pack (see Table 3). Most visitors were observed Sundays (on average 1564 visitors/Sunday) compared to Thursday (on average 1293 visitors/Thursday) and Friday (on average 1340 visitors/Friday). No visitors were present on Mondays as the park is closed for visitors on this weekday.

*Table 3: Overview of the hours spend observing each pack during the observation period at the WSC (26.07.2021-13.09.2021). Packs marked with a * are dog packs. For an explanation of the pack names, see Table 1.*

	Pack					
	Zuzi*	DumDum*	Hiara*			
Hours (h)	15.25	14.5	15.5			
	T’n’T	Maitu	Kenrok	Talitto	Geros	Nanuna
Hours (h)	13	16	16	15.5	15.75	16

2.4. Statistical Analysis

Prior to starting data collection, the two observers first went through a training period (~ 13.5 hours observation time) during which both observed either the animals or the visitors simultaneously (but independently) for assessing Inter-Rater reliability. Reliability between the observers was assessed by calculating Intraclass Correlation Coefficients for each variable (see Appendix, Table 12).

To test the hypothesis according to whether wolves will display more behaviors indicative of negative visitor perception compared to dogs (e.g., lower visibility, reduced social behaviors, more stress-related behaviors, see Table 2) in response to visitor number, noise level, and interactions we set up six General Linear Mixed Models (GLMM). To test for the differential effect of visitor numbers, noise levels, visitors' behaviors and presence of pet dogs on the two species, in all models, the following predictors were included: the interaction between the number of visitors and species, the interaction between the maximum noise level (LAmax) and species, the interaction between animal-directed behavior and species, the interaction between unruly behavior and species, the number of standing (Stationary Dogs) pet dogs and species, and the number of moving (Moving Dogs) pet dogs and species. Moreover, the weekday (Monday, Sunday, Thursday, and Friday), temperature, the time of day (as a continuous variable, expressed as numeric and z-transformed) and the occurrence of 'Staff' (collected as the total amount for each minute) were included as control predictors. Models for 'Visibility', 'Basics', 'Social Behavior', and 'Stress related' were GLMMs with binomial error structure and logit link, the model for 'Locomotion' was a GLMM with Conway-Maywell-Poisson error structure and logit link, while the model for 'Proximity' was a GLMM with Poisson error structure and logit link.

All Models were fitted in R (version 4.1.2 R Core Team 2021) using the function glmer from the lme4 packages (version 1.1-27.1, Bates et al., 2015) with the optimizer "bobyqa" or using the function glmmTMB from the package glmmTMB (version 1.1.2, Brooks et al., 2017) (used with Models 'Locomotion' and 'Proximity') with the optimizer "BFGS". To ease interpretation of estimates and to ease model convergence we z-transformed continuous predictors to a mean of zero and a standard deviation of one. Whenever a factor comprising more than two levels revealed to have a significant effect on the response variable, differences between the single levels of the factor were analyzed calculating least-squares means using the function emmeans (package emmeans)

To avoid pseudo replication, since we had repeated observations of the same pack, we included "Pack", and "Enclosure" as a random intercept effect. To model day-to-day variation, we also included a variable to account for the combination of subjects and date. Before entering the random slopes part of the model, factors were dummy coded and centered. To avoid overconfident models and to keep type I error rate at the nominal 5% level, we included all theoretical identifiable random slope components (Barr et al., 2013; Schielzeth & Forstmeier, 2009).

The original models also included all correlations between random intercepts and random slopes, but as these seem to be unidentifiable (with correlations being one or close to one), we removed these from the models (Matuschek et al., 2017).

To test the overall effects of the predictors of interest and to avoid cryptic multiple testing (Forstmeier & Schielzeth, 2011) each model was compared to a respective null model lacking the predictors of interest (the interaction between unruly behavior, animal directed behavior, the maximum noise level, the visitor number, and the number of standing and moving dogs), but otherwise being identical in the random effects part and the control predictors (weekday, temperature, start time, and staff) using a likelihood ratio test (*anova function*). If the full-null model comparison revealed a significant difference, we tested for their individual effects using likelihood ratio tests (Barr et al., 2013) with the *drop1* function in R.

To check for collinearity among the fixed effect predictors we determined variance inflation factors (VIF, Zuur et al., 2010) based on a standard linear model excluding interactions. This revealed that collinearity was not an issue (all VIFs < 2). All models are reported in the appendix (see Appendix, Table 13).

3. Results

The full-null model comparison revealed significant results for three out of the six tested models (Table 4). For a complete overview of all results see Appendix, Table 13.

Table 4: Results of the full-null model comparison conducted on the six tested models. Models 'Visibility', 'Basic Behavior', and 'Social Behavior' showed significant results (in bold). X^2 = chi-square, df = degrees of freedom.

Model	X^2	Df	p-value
Visibility	28.48	13	**0.008**
Basic Behavior	23.92	13	**0.032**
Social Behavior	33.57	13	**0.001**
Stress related	11.14	13	0.599
Locomotion	18.50	13	0.140
Proximity	12.26	13	0.507

3.1.1. Visibility

The full-null model comparison of the GLMM 'Visibility' revealed a significant difference (X^2= 28.48; df= 13; p= 0.008; see Table 4). In particular, the number of stationary dogs influenced the likelihood of subject's visibility (X^2= 7.98; df= 2; p= 0.019; see Appendix, Table 13). Animals were more likely to be visible when one pet dog was present than when no pet dog was present (0 vs. 1: z= -3.65; p= 0.001; see Table 5), in comparison to when two pet dogs were present (0 vs. 2: z= -1.42; p= 0.328; see Table 5), or the difference between one and two pet dogs (1 vs. 2: z= 0.74; p= 0.738; see Table 5). Further, the model revealed a significant effect of animal-directed visitor behavior on the animals' visibility (X^2= 7.62; df= 1; p= 0.006; see Appendix, Table 13).

Table 5: Overview of impact the presence and number on pet dogs had on animals' visibility. SE = standard deviation, df = degrees of freedom.

Levels	Estimate	SE	df	z value	p value
0 vs. 1	-0.847	0.232	Inf	-3.650	**0.001**
0 vs. 2	-0.551	0.387	Inf	-1.424	0.328
1 vs. 2	0.296	0.399	Inf	0.742	0.738

3.1.2. Basic Behavior

The full-null model comparison of the GLMM 'Basic Behavior' revealed a significant difference (X^2= 23.92; df= 13; p= 0.032, see Table 4). With increasing noise levels, dogs were more likely to show Basic Behaviors (Eating/Drinking, Defecation, Vocalization) than wolves (z= -4.509; p= $6,5*10^{-6}$; see Table 6). Further, there was a difference in the impact the number of moving dogs had on the tested animals (X^2= 7.75; df= 2; p= 0.021; Appendix, Table 13), with wolves and dogs more likely to show Basic Behavior if two or more moving dogs were present in comparison to when no dogs were present (0 vs. 2: z= -2.88; p= 0.011; see Table 6), or in comparison to when only one dog was present (1 vs. 2: z= -2.598; p= 0.025; see Table 6). No difference was found between when one dog was present to when no dogs were present (0 vs. 1: z= 0.514; p= 0.865; see Table 6).

Table 6: Overview of the impact of the maximum noise level (LAmax) and Moving Dogs. Results marked in bold are significant. SE = standard deviation, df = degrees of freedom.

	Level	Estimate	SE	df	z value	p value
LAmax	Wolf - Dog	-0.6	0.13	Inf.	-4.509	0.0000065
Moving dogs	0 vs. 1	0.202	0.39	Inf.	0.514	0.865
	0 vs. 2	-1.327	0.46	Inf.	-2.88	**0.011**
	1 vs. 2	-1.528	0.59	Inf.	-2.598	**0.025**

3.1.3. Social Behavior

The full-null model comparison of the GLMM ‘Social Behavior’ (Affiliative, Aggressive, Dominant, Submissive) was significant (X^2= 33.57; df= 13; p= 0.001; see Table 4). In particular, we found that animals were less likely to show social behaviors when the visitors showed unruly behavior (X^2= 11.93; df= 1; p= 0.0006; Appendix, Table 13).

Further, the model showed a tendency in the difference that the presence of Stationary dogs had on the tested animals (X^2= 5.63; df= 2; p= 0.059; Appendix, Table 13) with dogs and wolves showing more social behaviors when one stationary pet dog was present compared to when no dogs were present (0 vs. 1: z= -2.33; p= 0.052; see Table 7). No significant results were found in the difference between the presence of two or more dogs and no dogs (0 vs. 2: z= -1.964; p= 0.121; see Table 7), or the comparison between one and two or more dogs (1 vs. 2: z= 0.028; p= 1.0; see Table 7). Next to that, the number of moving dogs (X^2=8.19; df=2; p=0.017; Appendix, Table 13) had an influence on the tested animals, who were more likely to show an increase in Social Behavior, when two or more moving dogs were present compared to when no dogs were present (0 vs. 2: z= -3.12; p= 0.01; see Table 7). No significant effects were shown when no dogs were present compared to one dog (0 vs. 1: z= -0.16; p= 0.99;

see Table 7), or when comparing the effect of one and two or more dogs (1 vs. 2: z= -1.56; p= 0.26; see Table 7).

Table 7: Overview of the impact Stationary Dogs and Moving Dogs had on Social Behavior. Results in bold are significant or show a tendency. SE = standard deviation, df = degrees of freedom.

	Level	Estimate	SE	df	z value	p value
Stationary Dogs	0 vs. 1	-0.999	0.429	Inf	-2.33	**0.052**
	0 vs. 2	-0.984	0.501	Inf	-1.964	0.121
	1 vs. 2	0.015	0.539	Inf	0.028	1.0
Moving Dogs	0 vs. 1	-0.15	0.96	Inf	-0.16	0.99
	0 vs. 2	-1.89	0.61	Inf	-3.12	**0.01**
	1 vs. 2	-1.73	1.11	Inf	-1.56	0.26

3.1.4. Stress related

For the GLMM ‘Stress related’ (Autogrooming, Yawning, Body shaking, Lip licking, Scratching), no significant results were found (X^2= 11.14; df= 13; p= 0.599; see Table 4).

3.1.5. Locomotion

For the GLMM ‘Locomotion’, no significant results were found (X^2= 18.5; df= 13; p= 0.14; see Table 4).

3.1.6. Proximity

For the GLMM ‚Proximity’, no significant results were found (X^2= 12.26; df= 13; p= 0.507; see Table 4).

4. Discussion

With this study, we found no effect of visitor number on animal behavior. However, dogs were more likely to show eating/drinking, defecation, and vocalization behavior with increasing noise levels than wolves. Next to that, the animals were more likely to be visible when visitors showed behaviors such as trying to lure the animals, taking pictures, pointing towards them, and making animal-like noises, and were less likely to show affiliative, aggressive/dominant, and submissive behavior when visitors performed unruly behavior (feeding the animals, shouting, or throwing objects at them, as well as human- and dog trespassing of the wooden barriers). Next to that, we were able to observe an influence of the number and locomotive state of pet dogs on animals visibility, basic behaviors, and social behaviors. None of the variables investigated here affected the likelihood of the animals showing stress-related behaviors, nor their locomotive state, nor their proximity to pack members.

While we expected wolves to show more negative behavior under the influence of visitors, visitor count by itself had no influence on animals' behavior, for neither dogs, nor wolves. This is contrary to the results of a study on Mexican wolves, where higher visitor numbers resulted in higher fecal cortisol levels, indicative of a higher stress response, i.e., possibly a negative visitor perception (Pifarré et al., 2012). However, the lack of effect in the present study might be routed in how the animals at the WSC are brought up. While the wolves in the study by Pifarré et al. (2012) were indeed born in captivity and lived in their respective enclosures for more than one year, nevertheless, the animals at the WSC are hand-raised and highly socialized to humans (Range & Virányi, 2014). In fact, from puppyhood on they are raised by human caregivers and have also extensive contact with familiar human trainers later on, but also with unfamiliar visitors that can book encounters with the animals. Further, as the WSC only uses positive reinforcement during training, making visitor encounters a positive event for the animals. Following Hosey (2008), the animals at the WSC might have therefore formed a neutral, or even positive relationship with the visitors through generalizing their positive interactions with a few familiar and unfamiliar humans towards unfamiliar visitors in general (Hosey, 2008). In the end, a positive, or at least neutral realtionship from the animals towards the visitors, is the ultimate goal for institutions keeping animals.

When looking at the other closely tied variable, visitor noise, we could find an effect on animal behavior. While in a study by Boyle et al. (2020) visitor presence vs. absence was not of influence on the tested wolves, which is in line with our results, alert behavior (defined as looking in one direction while resting with head up, standing, walking, running, stalking, sitting upright, or vocalizing) increased when visitor noise was used as the independent variable. While we did not specifically tested for alert behavior in the same categorization as done by Boyle et al. (2020), we did as well test for locomotion and vocalization. We could not replicate the finding that the noise level had an influence on locomotion, however we could find a positive effect of the noise level on the ‘Basic Behavior’ category (including vocalization) for dogs. This might have different reasons. The study by Boyle et al. (2020) only tested four wolves for 8h, which is a comparably small period compared to the more of 90h analyzed in the present study. Thus, those results might be a false positive, as our study had a longer observation time with a larger study sample size and might therefore be more representative. Further, similar to the correlation discussed above between visitor number and the effects on the animals, the dogs and wolves might simply be well habituated to the visitors at the WSC and their noise levels. Because only dogs showed a significant correlation between visitor noise and the ‘Basic Behavior’ category, this might be routed in the domestication process. In line with our expectations following the ‘Hypersociability Hypothesis’, we expected dogs to be more engaged with humans, as a result of being more attracted towards them (vonHoldt et al., 2017). During domestication, dogs had to adjust how they respond to humans, i.e., adjust their own vocal response in order to provide information about their own inner state (Pongrácz et al., 2010). This might make them more likely to use barking, i.e., vocalization, as a tool to react to higher visitor noise levels in an effort to communicate with humans. Further, as they started to live in closer proximity to human settlements (Marshall-Pescini, Cafazzo, et al., 2017), they might have better adapted to human noise in their behavioral response, such as vocalization and eating/drinking behavior. However, as the observed behaviors in this study had to be taken together in quite broad categories because of their rare occurrence, a future study could analyze especially vocalization as a separate variable could be an interesting step to investigate further how dogs and wolves differ in their vocal reaction to humans and give further information if and how the eating and drinking behavior is of relevance.

When controlling for human behaviors, we found that animals of both species were more visible when visitors showed animal-directed behavior (i.e., luring, taking pictures, pointing at the animals, producing vocalizations similar to those of the animals). However, with observational studies like the present, it is difficult to understand the cause-effect relationship between the two elements. For instance, visitors might have engaged in more animal-directed behaviors because the animals were visible, rather than the other way round (for a review see Sherwen & Hemsworth, 2019). This possibly directional effect was also discussed in other studies, such as a study on felid activity in relation to zoo visitor absence or presence and visitor interest in the exhibition (Margulis et al., 2003). In the study by Margulis et al. (2003), six felid species were observed in their behavior, i.e., their active and inactive states. Next to that, visitor interest in the exhibit (measured as visitor length of stay and observable response to the animals) was collected. In line with our findings, the authors suggested that especially with large animals, such as big cats, but possibly also canines like in the present study, animal activity, and as a result visibility, is likely to influence visitor interest and length of stay. Nevertheless, the authors admitted that the likelihood of animal activity might very well be influenced by visitor behavior (Margulis et al., 2003). This shows how difficult it is to disentangle the direction of the relationship between animal activity and animal-directed behavior by the visitors properly. To control for the direction of the effect in a future study, and to gain more insights about the direction of the effect, a one-way mirror where only visitors can observe animals, but not vice-versa, could be used (Delfour & Marten, 2001).

When visitors tried to feed the animals, shout at them, throw objects, pass behind the rails, or let their dogs do so (the so-called ‘Unruly Behavior’), we found that the animals showed less aggressive/dominant and submissive, but also less affiliative behaviors. This might suggest that such unruly behaviors are disruptive for the animals who are hindered from showing their normal range of social behaviors. Over time, this might present a problem in the animals’ welfare, as it has been suggested that social behavior has a rewarding effect, resulting in a positive welfare state (for a review on the connection between positive emotions to enhance animal welfare see Boissy et al. (2007)). Therefore, if these behaviors cannot be performed, overall welfare might be lower. In addition, the ‘Unruly Behavior’ category stands out from the other behaviors we controlled for, as they violate park rules. When the observers became aware of such behavior, they had to reprimand the visitors. As this made the subjects of the reprimand and the people surrounding them aware of the observers, and therefore probably reduce the likelihood to show such behaviors again, measurements to prevent such incidents in the beginning would be beneficial. For example, more, and more obvious signs with the park rules around all enclosures could be a comparably easy and affordable option.

Nevertheless, in exhibits where pet dogs are allowed, not only the presence and behavior of the human visitors might influence the animals, but also the visiting dogs. Therefore, we decided to further control for the presence and number of pet dogs. We found that animals were more likely to be visible if one stationary pet dog was present, compared to when zero, or two dogs were present. For both dogs (Bonanni et al., 2011) and wolves (Cassidy et al., 2015) a larger pack size, compared to the opponent pack seems to be of advantage. With only one exception (Gero's), packs at the WSC have two members. Therefore, animals might be more likely to face 'opponents', i.e., outgroup pet dogs, when those are inferior in number. Further, all enclosures are surrounded by a fence, giving the animals inside the security to be protected from all possible threats or agonistic encounters on the outside and the excellent hiding opportunities through the provided huts and natural vegetation. Adding to that, with two or more moving pet dogs, dogs and wolves were more likely to show behavior from the 'Basic behavior' category. Vocalization is a possibility to understand emotions (Albuquerque et al., 2016) and to initiate interaction (Feddersen-Petersen, 2000). These interactions can of course go both ways, with also pet dogs initiating interactions. Therefore, both, dogs and wolves, might show more vocalizations with moving dogs, as they have less time to use other information cues (Albuquerque et al., 2016) and moving objects seem to be of great interest in general (Völter & Huber, 2021). At the same time, vocalization is used as a tool to defend their territory and to convey information (Harrington & Mech, 1979). Adding to that, the presence of both stationary and moving pet dogs was found to correlate with subjects being more likely to show affiliative, aggressive, dominant, and submissive behavior ('Social Behavior'). Unfortunately, however, as these behaviors only happened a few times during the observation period, it was not possible to differentiate in the analysis between social behaviors towards pack members, and social behaviors towards pet dogs as originally planned. Still, while they are also quite intertwined with each other, it is important to try to discuss both possibilities, and the effects for the animals. Affiliative behavior was only possible to perform towards pack members, as pet dogs did not have any possibility to be in physical contact with the observed animals. Body contact, i.e., affiliative behavior, can help to cope with stressful situations and be part of a social support system (for reviews see Massen et al., 2010; Rault, 2012; Cimarelli et al., 2021; Morrison, 2016). Therefore, if pet dogs did pose a stressor on the animals, a rise in affiliative behavior was to be expected. Aggressive/dominant behavior towards another pack member might be the result of displacement behavior (Moffat, 2008; Simpson, 1997). Because the 'direct opponent', i.e., the unfamiliar pet dog outside the enclosure, could not be reached, animals could show agonistic behaviors towards their pack mate as a substitute for their aggressions' original target. Displacement behavior can be found in an inner conflict, when the animal wants to perform a certain activity, i.e., performing dominant/aggressive behavior towards the pet dog, but is not able to do so, and as a result performs a different action, i.e., showing dominant behavior towards the pack mate. In this case, the pet dogs could have been seen as a threat to the animals' territory and provoked an aggressive/dominant reaction, especially when trespassing the railing (Haug, 2008; Tikkunen & Kojola, 2019). If the reactions were more clearly towards the pet dogs, communication might again be a possible reason. Both canine species, dogs and wolves, live in highly social environments (Marshall-Pescini, Cafazzo, et al., 2017), and have to be able to read their opposites' social cues. Therefore, a possible explanation as to why both species showed more social behaviors and vocalizations with more pet dogs being present might suggest their willingness to interact and collect information through social cues (Albuquerque et al., 2016). However, in the case of the present study, as we could not clearly differentiate in the analysis towards whom the animals reacted, these are mostly speculations, and for future studies it would be helpful to have more data specifically on these behaviors.

Following our hypothesis that wolves would be more negatively influenced by visitors and their behavior, we expected wolves to show lower proximity petween packmates, compared to dogs, if visitors were to be seen as fear provoking, or stressful. However, in the present study, no significant results for differences in proximity between the animals could be found, for neither dogs, nor wolves. This might again be explained by the fact that all animals at the WSC are well and extensively trained to human contact, which has been shown to reduce the stress response for the animals (Vasconcellos et al., 2016). As a result, animals might need less of a social support system (for reviews see Massen et al., 2010; Rault, 2012; Cimarelli et al., 2021; Morrison, 2016), and therefore have no need for closer proximity with their pack mates. While we could also find no influence of the visitors on animals stress response for a future study it might be helpful to video record the animals, so that very fast behaviors, especially fine stress-related ones, can be analyzed off-line more precisely.

As another measurement to investigate the animals' response to visitors, we decided to collect their locomotive state (Sherwen & Hemsworth, 2019), which in the present study was done by collecting if the animal was sleeping, lying, sitting, or moving at the beginning of every minute of the 30-minute observation period. We could not find an influence of the visitors on animals' locomotive state, suggesting that the animals were not influenced by visitors in a negative way. However, it is necessary to add that data collection happened during the summer months. As already shown in other studies, animals tend to be significantly less active during spring and summer months with activity levels being the lowest for temperatures from 30°C upwards (master thesis, Wacker, 2020; Margulis et al., 2003). In a study on free-ranging wolves it was found that time of the year, but also time of the day, were of influence, with activity levels being higher with cooler temperatures (Theuerkauf et al., 2003). However, temperatures over 25°C only happened on 11 days of data collection, suggesting that temperature might have only played a minor role in animal behavior.

While 'Weekdays' only acted as a control variable, it might be noteworthy that there was a difference in the visitor count over the week. As expected, most visitors visited the park on Sundays (1564 visitors/Sunday) compared to Thursday (1293 visitors) and Friday (1340 visitors). In future studies, integrating the weekday as a test predictor and not only as a control variable could grant further insight in the effect of weekday, and therefore most likely visitor count, on animal behavior.

With this study, we aimed to analyze the possible differences in how visitors would affect the dogs and wolves living at the WSC. Based on the 'Hyper Sociability Hypothesis', we expected that wolves would be more negatively influenced by visitor numbers, their noise level, and their behavior. As an addition, we also controlled for the influence of visitor pet dogs, as, different to most other institutions, they are allowed at the WSC. We were able to determine visitor noise levels as influential on dogs eating/drinking, defecation, vocalization behaviors, but not on wolves. However, both species were more visible with visitors showing behaviors such as trying to lure the animals, taking pictures, pointing towards them, and making animal-like noises. At the same time, they were less likely to show affiliative, aggressive/dominant, and submissive behavior when visitors performed unruly behavior (feeding the animals, shouting, or throwing objects at them, as well as human- and dog trespassing of the wooden barriers). Against our hypothesis, visitor count was not found to be of influence, which might be best explained by the extensive socialization all animals at the WSC receive from puppyhood on. Further, we could find no correlation between the visitors and animals stress-responses, nor their locomotive state, nor their proximity. Pet dogs however were found to be of influence on animals visibility, basic behavior and social behavior. For a future study, we would recommend video recording the observation sessions for a possibility to detect very fine behaviors more easily, as such under the stress-related category. Further, we would recommend more, and clearer signs with the park rules throughout the park to prevent unruly visitor behavior already in the beginning.

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Appendix

Table 8: Coding Sheet during the observations. The different behaviors/ locomotive states and their codes are listed. For a detailed explanation of the behaviors, see Table 2. Grouping of the behaviors differed for the analysis.

	Behavior	Code	Behavior	Code	Locomotion	Code	Proximity	Code
Date	Eating/Drinking	ED	Autogrooming	A	Moving	M	Alone	A
Time	Defecate	D	Yawning	Y			1 Body Length	1B
Temperature	Affiliative	Af	Body Shaking	BS	Immobile Standing	ISt	3 Body Length	3B
Weather	Agonistic-Pack	Agg-w	Lip Licking	LL	Immobile Lying	Ily	Together	T
Enclosure	Agonistic-Outside	Agg-d	Scratching	SC	Sleeping	S	Not Visible	N.A.
	Dominant-Pack	Dom-w	Vocalising	V				
	Dominant-Outside	Dom-d						
	Submissive	Sub						

Table 9: Example of an observation sheet. During observation, times will go up to 30. The Table includes all points to observe, as well as the regarding time stamps with the animals.

Animal	Imara	Hiari	Imara	Hiari	Imara	Hiari
T	1	1	2	2	3	3
Locomotion						
Visibility						
Proximity						
Behavior						
Notes						

Table 10: Timeslots for the observed animals and relative enclosure. Part 1.

Day	Timeslots	Zuri + Enzi	Layla + Panya	Imara + Hiari	Taima + Takoa	Enclosure	Etu + Maikan	Enclosure
Monday	9-11	02.08.2021	23.08.2021	06.09.2021	09.08.2021	9b	09.08.2021	6
		09.08.2021	30.08.2021	13.09.2021	30.08.2021		30.08.2021	9b
		16.08.2021						
	11-13	02.08.2021	23.08.2021	06.09.2021	16.08.2021	9a	02.08.2021	6
		09.08.2021	30.08.2021	13.09.2021	23.08.2021	9a	23.08.2021	9b
		16.08.2021			30.08.2021	9a	13.09.2021	9a
	13-15	26.07.21	16.08.2021	06.09.2021	02.08.2021	9a	09.08.2021	6
		09.08.21	23.08.2021		13.09.2021	22	30.08.2021	
			30.08.2021					
	15-17	02.08.2021	23.08.2021	30.08.2021	26.07.2021	9a	26.07.21	6
				13.09.2021	23.08.2021	9a	16.08.21	9b
					13.09.2021	22	06.09.2021	9b
Thursday	9-11	05.08.2021	19.08.2021	02.09.2021	12.08.2021	9b	05.08.2021	6
		12.08.2021	26.08.2021	09.09.2021	19.08.2019	9a	26.08.2021	9b
							02.09.2021	9b
	11-13	12.08.2021	19.08.2021	02.09.2021	26.08.2021	9a	19.08.2021	9b
			26.08.2021	09.09.2021			09.09.2021	9b
	13-15	12.08.2021	19.08.2021	02.09.2021	19.08.2021	9a	02.09.2021	9b
			26.08.2021	09.09.2021			09.09.2021	9b
	15-17	12.08.2021	19.08.2021	02.09.2021			12.08.2021	6
				09.09.2021				
Friday	9-11	06.08.2021	20.08.2021	03.09.2021	20.08.2019	22	06.08.2021	6
		13.08.2021	27.08.2021	10.09.2021			03.09.2821	9b
	11-13	06.08.2021	20.08.2021	03.09.2021	20.08.2021	9a	13.08.2021	6

		01.08.2021	27.08.2021	10.09.2021	27.08.2021	22	01.08.2021	6
		13.08.2021					10.09.2021	9a
	13-15	13.08.2021	20.08.2019	03.09.2021	06.08.2021	9b	06.08.2021	9a
				10.09.2021				
	15-17	06.08.2021	27.08.2021	03.09.2021	06.08.2021	9b	10.09.2021	22
				10.09.2021	13.08.2021	9b		
Sunday	9-11	01.08.2021	22.08.2021	05.09.2021	08.08.2021	9b	15.08.2021	9b
		15.08.2021	29.08.2021	12.09.2021	22.08.2021	9a	12.09.2021	22
	11-13	08.08.2021	22.08.2021	05.09.2021	08.08.2021	9b	29.08.2021	9b
		01.08.2021	29.08.2021	12.09.2021	29.08.2021	9a	05.09.2021	9b
		15.08.2021					12.09.2021	22
	13-15	01.08.2021	22.08.2021	05.09.2021	15.08.2021	9a	15.08.2021	9b
		08.08.2021	29.08.2021	12.09.2021				
		15.08.2021						
	15-17	01.08.2021	22.08.2021	05.09.2021	01.08.2021	9a	08.08.2021	6
		15.08.2021	29.08.2021	12.09.2021				
dogs in 10a		until the 16th of August	until the 30th August	until 13th September				

Table 11: Timeslots for the observed animals and relative enclosure. Part 2.

Day	Timeslots	Kenai + Amarok	Enclosure	Tala + Chitto	Enclosure	Nanuk + Una	Enclosure	Geronimo + Wamblee + Yukon	Enclosure
Monday	9-11	16.08.2021	22	02.08.2021	22	02.08.2021	23a	16.08.2021	6
		23.08.2021	22	23.08.2021	23	06.09.2021	22	13.09.2021	6

		06.09.2021	9a	06.09.2021	23				
	11-13	02.08.2021	9b	09.08.2021	24	06.09.2021	22	09.08.2021	23
		30.08.2021	22	13.09.2021	9a	13.09.2021	23	16.08.2021	6
								23.08.2021	6
	13-15	09.08.2021	22	16.08.2021	23	06.09.2021	22	26.07.21	22
		23.08.2021	22			13.09.2021	23	02.08.21	23a
	15-17	26.07.2021	9b	02.08.2021	22	30.08.2021	22	02.08.2021	23
		02.08.2021	9b	09.08.2021	9a	06.09.2021	22	09.08.2021	23
		16.08.2021	22	23.08.2021	23				
				30.08.2021	23				
Thursday	9-11	12.08.2021	22	05.08.2021	22	02.09.2021	22	19.08.2021	6
				09.09.2021	23	09.09.2021	22	26.08.2021	6
	11-13	12.08.2021	22	19.08.2021	23	02.09.2021	22	12.08.2021	23
		26.08.2021	22			09.09.2021	22	02.09.2021	6
	13-15	26.08.0221	22	12.08.2021	24	02.09.2021	22	12.08.0202	23a
						09.09.2021	22		
	15-17	09.09.2021	9a	02.09.2021	23	02.09.2021	22	09.09.2021	6
Friday	9-11	06.08.2021	22	06.08.2021	6	27.08.2021	24	20.08.2021	6
		13.08.2021	22	27.08.2021	23	03.09.2021	22	13.08.2021	23
		10.09.2021	9a					10.09.2021	6
	11-13	20.08.2021	22	13.08.2021	24	03.09.2021	22	06.08.2021	23
		01.08.2021	9b	03.09.2021	23	10.09.2021	22	27.08.2021	6
	13-15	20.08.2021	22	20.08.2021	23	27.08.2021	24	13.08.2021	23
		03.09.2021	9a	10.09.2021	23	03.09.2021	22	10.09.2021	6
	15-17	13.08.2021	22	06.08.2021	6	03.09.2021	6	27.08.2021	6
		19.08.2021	22	19.08.2021	23	10.09.2021	9a	03.09.2021	6

Sunday	9-11	15.08.2021	22	01.08.21	22	02.08.2021	23a	08.08.2021	23
		29.08.2021	22	22.08.2021	23	05.09.2021	22	05.09.2021	6
				29.08.2021	23	12.09.2021	9a		
	11-13	08.08.2021	9a	02.08.2021	22	05.09.2021	22	15.08.2021	6
		15.08.2021	22	22.08.2021	23	12.09.2021	9a	22.08.2021	6
	13-15	22.08.2021	22	01.08.2021	22	05.09.2021	22	08.08.2021	23
		05.09.2021	9a	12.09.2021	23	12.09.2021	9a	29.08.2021	6
	15-17	08.08.2021	9a	15.08.2021	23	01.08.2021	23	15.08.2021	6
		12.09.2021	9b	05.09.2021	23	05.09.2021	22	12.09.2021	6

Table 12: Results of the Twoway Agreement Singlescore Intraclass Correlation. Shown are the results for both the animal and the human observations.

Variable name	Intraclass Correlation	p-value	95% Confidence Interval	
Animal Variables			Lower Bound	Upper Bound
Eating/Drinking	0.876	0	0.864	0.886
Defecate	0.899	0	0.89	0.908
Affiliative	0.799	0	0.782	0.815
Agonistic Aggressive	0.889	0	0.878	0.898
Agonistic Dominant	N.A.	0.5	N.A.	N.A.
Submissive	0.667	5.93e-228	0.64	0.692
Autogrooming	0.836	0	0.822	0.85
Yawning	0.869	0	0.857	0.88
Body Shaking	0.977	0	0.974	0.979
Lip Licking	0.899	0	0.89	0.907
Scratching	0.835	0	0.821	0.849
Vocalizing	0.97	0	0.967	0.973
Locomotion	0.944	0	0.939	0.949
Visibility	0.964	0	0.958	0.969
Proximity	0.856	0	0.843	0.868
Human Variables			Lower Bound	Upper Bound
Visitor Number	0.957	0	0.951	0.962
Moving Dogs	0.843	3.17e-227	0.822	0.861
Stationary Dogs	0.855	1.49e-240	0.835	0.872

Shouting	0.976	0	0.972	0.979
Dog Trespassing	0.933	0	0.923	0.941
Human Trespassing	0.915	0	0.903	0.925
Luring	0.959	0	0.953	0.964
Picture	0.92	0	0.909	0.93
Pointing	0.895	1.39e-296	0.881	0.908
Animal Voices	0.957	0	0.951	0.963
Gender	0.943	2.43-238	0.932	0.952
Age	0.942	2.05e-235	0.931	0.951

Table 13: Results of the final models. Models for Locomotion and Proximity were too low in power; therefore, no results can be shown. Variable names are the original names used in the statistics and have been altered afterwards for better understanding.

Visibility - Final Model				**Basic Behavior – Final Model**			
	X^2	df	p-value		X^2	df	p-value
none	NA	NA	NA	none	NA	NA	NA
unruly	0.46	1	0.4954	unruly	0.00	1	0.996
z.directed	7.62	1	**0.0058**	z.directed	0.53	1	0.468
z.lamax_clean	1.19	1	0.2744	z.visitor_n_clean	0.24	1	0.622
z.visitor_n_clean	0.35	1	0.5527	dog_s_n_clean	0.06	2	0.968
dog_m_n	1.21	2	0.5471	**dog_m_n**	7.75	2	**0.021**
dog_s_n_clean	7.98	2	**0.0185**	**weekday**	12.88	3	**0.005**
species	0.04	1	0.8485	**z.temp**	5.45	1	**0.020**
weekday	0.53	3	0.9112	z.start_time	0.84	1	0.360
z.temp	0.04	1	0.8325	authority	1.07	1	0.300
z.start_time	1.09	1	0.2955	**z.lamax_clean:species**	9.48	1	**0.002**
authority	6.54	1	**0.0106**				

Visibility - Final Model Estimates

	Estimate	Std. Error	z value	p–value
(Intercept)	2.17	1.57	1.38	0.1664
unruly1	0.16	0.24	0.70	0.4861
z.directed	**0.52**	**0.15**	**3.60**	0.0003
z.lamax_clean	0.27	0.21	1.27	0.2037
z.visitor_n_clean	-0.10	0.17	-0.62	0.5384
dog_m_n1	-0.24	0.22	-1.06	0.2895
dog_m_n2	0.15	0.39	0.38	0.7071
dog_s_n_clean1	**0.85**	**0.23**	**3.65**	0.0003
dog_s_n_clean2	**0.55**	**0.39**	**1.42**	0.1545
speciesdog	-0.73	3.74	-0.19	**0.8456**
weekdayfriday	-0.14	0.82	-0.18	**0.8608**
weekdaysunday	0.00	0.79	0.01	**0.9958**
weekdaymonday	-0.70	1.04	-0.67	**0.5016**
z.temp	-0.24	1.09	-0.22	**0.8285**
z.start_time	1.05	0.96	1.10	**0.2728**
authority1	**0.86**	**0.23**	**3.77**	0.0002

Basic Behavior - Final Model Estimates

	Estimate	Std. Error	z value	p-value
(Intercept)	-4.295	0.405	-10.61	0.0000
unruly1	-0.003	0.338	-0.01	0.9937
z.directed	0.082	0.108	0.76	0.4496
z.lamax_clean	0.085	0.092	0.93	0.3546
speciesdog	0.755	0.576	1.31	0.1902
z.visitor_n_clean	-0.041	0.083	-0.49	0.6230
dog_s_n_clean1	0.011	0.304	0.04	0.9712
dog_s_n_clean2	-0.094	0.384	-0.24	0.8070
dog_m_n1	**-0.202**	**0.392**	**-0.51**	**0.6074**
dog_m_n2	**1.327**	**0.461**	**2.88**	**0.0040**
weekdayfriday	**0.943**	**0.410**	**2.30**	**0.0216**
weekdaysunday	**0.657**	**0.377**	**1.74**	**0.0814**
weekdaymonday	**1.721**	**0.485**	**3.55**	**0.0004**
z.temp	**-0.373**	**0.163**	**-2.29**	**0.0218**
z.start_time	0.236	0.258	0.91	0.3608
authority1	-0.574	0.603	-0.95	0.3410
z.lamax_clean: speciesdog	**0.598**	**0.133**	**4.51**	**0.0000**

Social Behavior - Final Model

	X^2	df	p-value
none	NA	NA	NA
unruly	11.93	1	**0.0006**
z.directed	0.01	1	0.9244
z.lamax_clean	2.67	1	0.1021
z.visitor_n_clean	0.66	1	0.4148
dog_s_n_clean	5.63	2	**0.0598**
dog_m_n	8.19	2	**0.0167**
species	2.24	1	0.1343
weekday	5.62	3	0.1317
z.temp	1.45	1	0.2292
z.start_time	1.92	1	0.1657
authority	3.14	1	**0.0765**

Stress related - Final Model

	X^2	df	p-value
none	NA	NA	NA
dog_s_n_clean	1.88	2.00	0.3900
dog_m_n	1.64	2.00	0.4394
weekday	5.96	3.00	0.1134
z.temp	4.44	1.00	0.0351
z.start_time	5.69	1.00	0.0170
authority	1.03	1.00	0.3108
unruly:species	0.00	1.00	0.9494
species:z.directed	0.62	1.00	0.4321
species:z.lamax_clean	0.11	1.00	0.7371
species:z.visitor_n_clean	0.00	1.00	1.0000

Social Behavior - Final Model Estimates

	Estimate	Std. Error	z value	p-value
(Intercept)	-5.46	0.54	-10.20	0.0000
unruly1	**-4.93**	**1.95**	**-2.53**	**0.0114**
z.directed	0.02	0.21	0.10	0.9242
z.lamax_clean	0.36	0.18	1.97	0.0486
z.visitor_n_clean	-0.16	0.20	-0.82	0.4137
dog_s_n_clean1	**1.00**	**0.43**	**2.33**	**0.0198**

Stress related - Final Model Estimates

	Estimate	Std. Error	z value	p-value
(Intercept)	-1.875	0.214	-8.77	0.0000
unruly1	-0.069	0.194	-0.35	0.7234
speciesdog	-0.115	0.352	-0.33	0.7441
z.directed	0.136	0.048	2.83	0.0046
z.lamax_clean	-0.026	0.062	-0.42	0.6749
z.visitor_n_clean	0.020	0.063	0.32	07506

dog_s_n_clean2	**0.98**	**0.50**	**1.96**	**0.0495**
dog_m_n1	**0.15**	**0.96**	**0.16**	**0.8741**
dog_m_n2	**1.89**	**0.61**	**3.12**	**0.0018**
speciesdog	-1.20	0.72	-1.67	0.0939
weekdayfriday	1.12	0.50	2.24	0.0254
weekdaysunday	0.21	0.52	0.40	0.6871
weekdaymonday	-0.83	0.93	-0.89	0.3716
z.temp	-0.30	0.25	-1.24	0.2147
z.start_time	-0.33	0.25	-1.32	0.1856
authority1	-2.26	1.93	-1.17	0.2415

dog_s_n_clean1	0.155	0.188	0.82	0,4102
dog_s_n_clean2	-0.239	0.240	-1.00	0.3182
dog_m_n1	-0.559	0.477	-1.17	0.2411
dog_m_n2	-0.208	0.373	-0.56	0.5776
weekdayfriday	-0.160	0.160	-1.01	0.3147
weekdaysunday	0.165	0.139	1.18	0.2364
weekdaymonday	0.274	0.190	1.44	0.1495
z.temp	-0.241	0.094	-2.58	0.0099
z.start_time	0.186	0.058	3.18	0.0015
authority1	-0.153	0.150	-1.02	0.3069
unruly1:speciesdog	0.032	0.493	0.06	0.9486
speciesdog:z.directed	-0.138	0.176	-0.78	0.4341
speciesdog:z.lamax_clean	-0.036	0.107	-0.34	0.7330
speciesdog:z.visitor_n_clean	0.001	0.150	0.01	0.9952