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Perceptions of animal personality compared with objective measures of animal personality in captive ungulates and carnivores

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Abstract

The two most widely used methods for animal personality assessment include observational coding of behaviour and the rating of traits through questionnaires. Here the two are assessed side by side in order to determine whether or not they are consistent with one another. Six zoo keepers from one zoo were asked to rate the personality of 12 individuals they cared for. Animals studied included a range of carnivores and ungulate species which consisted of Eurasian brown bear (Ursus arctos arctos), Arctic fox (Vulpes lagopus), red fox (Vulpes vulpes), European pine marten (Martes martes), Eurasian otter (Lutra lutra), Eurasian wolf (Canis lupus lupus), red deer (Cervus elaphus), European bison (Bison bonasus), wild boar (Sus scrofa), Konik horse (Equus ferus caballus), Soay sheep (Ovis aries) and reindeer (Rangifer tarandus). Six measures of personality were taken for each individual: keeper rating for personality traits, keeper rating for behaviour traits and observational measures of personality, for the two dimensions neuroticism and extraversion. The dimensions extraversion and neuroticism were used as these are most consistently found across species. Results showed that neither taxa were more extraverted or neurotic than one another across all measures of personality. No significant relationship was found between the observational measures of personality and the keeper scores of personality for both dimensions. This provides evidence to suggest that the two methods of assessing personality traits in captive species do not yield the same results and therefore each method, alone, cannot provide an accurate measure of non-human animal personality.

Introduction

For the past two decades non-human animal personality research has increased in popularity despite previous criticisms that it was anthropomorphic (Highfill et al., 2010). While there is much research conducted on captive, and less so wild, individuals across a range of species, there has not been one agreed upon method for conducting animal personality assessments (Gosling, 2008). While the majority of all animal personality studies have used the observational behavioural coding method, the trait rating method is utilised preferentially in zoo animal research (Watters & Powell, 2012).

Animal personality can be defined as behavioural traits of an individual which are reliable over time in predicting how the individual may respond to various stimuli (Capitanio, 1999). An animal's personality consists of multiple personality dimensions, or factors (Gosling & John, 1999). These personality dimensions, are made up of a number of traits which are either positively or negatively correlated with one another (Andersson et al., 2014). While it is unclear how many personality dimensions there are in non-human animals it is known that different species have different combinations of these dimensions, however boldness is a trait which has been reliably reported across many species (*ibid*).

The Five-Factor Model (Goldberg, 1990) is the most widely accepted model of personality structure in humans and is made up of the dimensions: extraversion, neuroticism, agreeableness, openness and conscientiousness. For each dimension, or factor, there are multiple traits which define it and there is also an opposite dimension (Gosling & John, 1999), for example extraversion is opposed by introversion and may consist of traits such as energetic and talkative compared with lethargic and silent (Goldberg, 1990). These factors appear to be robust and widely accepted in humans but have not always been apparent in non-human animals (Gosling & Vazire, 2002).

In order to measure personality in non-human animals, adaptations of the Five-Factor Model are often used (Weiss et al., 2009). The dimensions extraversion, neuroticism, and agreeableness have been most easily measured across many non-human species whereas factors such as openness and conscientiousness are much less evident in non-human animals (*ibid*). Chimpanzees have been the only species found to have a consistent, separate conscientiousness dimension – possibly due to it being fairly recently evolved in the Homininae (Gosling and John, 1999).

Most animal behaviour research will use one of the two most common methods to assess personality in captive animals; rating of traits or behavioural coding (Gosling, 2001). Trait rating is often referred to as the more subjective of the two methods as it relies on memories of specific behaviours and it requires an individual who knows the animal well, usually the keeper, to score it for a variety of behavioural or personality traits which then combine to create a personality score (Watters & Powell, 2012). These traits are usually scored on a Likert scale and are tailored to ask specific questions according to which personality dimensions are being studied. This method requires only a small amount of time for the person rating the animal to produce a personality profile by completing a questionnaire, however much more time is needed to develop a questionnaire specifically for seeking out different personality dimensions across different species (*ibid*).

Weiss et al. (2009) investigated the influence of cultural background on the reliability of the trait rating method. Their results showed two cultures, Japanese and American, were reliably able to rate the same chimpanzee (*Pan troglodytes*) individuals and showed similar ratings for all personality dimensions. Reliability of the trait rating method has been consistently found in chimpanzees (King & Figueredo, 1997; Martin, 2005) and has also been found in other species such as the Scottish wildcat (*Felis silvestris grampia*; Gartner & Weiss, 2013). However, although these studies show a reliability of the trait rating method, they do not attempt to measure its validity. Moreover, there is evidence to suggest that rater reliability depends upon aspects such as experience and animal keeper relationships (Highfill et al., 2010).

The second of the two methods, behavioural coding, is presented as a more objective method of analysing animal personality as it relies on real life measurements of behaviour (Borell et al., 2016). Behavioural coding requires a researcher to observe an animal and its behaviours over a prolonged amount of time in order to record the frequency of occurrence of certain behaviours over various situations and environments. Behaviours are often recorded through the use of an ethogram specific to the personality dimensions being studied (Watters & Powell, 2012). This type of research is much more time consuming in terms of collecting the data and also designing an ethogram suitable for the personality dimensions being measured.

When the behavioural coding method is utilised, it is most common for animals to be put into test situations in a novel environment or with a novel object in order to quickly assess personality dimensions, such as boldness (Bremner-Harrison et al., 2004; Natoli et al., 2005; Andersson et al., 2014). However placing animal subjects in these novel test environments to conduct rapid assessments of behavioural traits has been shown to create data that is not representative of the behaviours observed in familiar environments and may lead to the misclassification of behavioural traits (Biro, 2012). Introducing novel environments or objects can cause unnecessary stress and therefore changes in behavioural and physiological responses to environmental stimuli (*ibid*). As some individuals may have never encountered novel situations or objects previously, and may even avoid them, their behavioural responses in these situations cannot be representative of their usual behaviour (*ibid*).

An alternative method of behavioural coding is simply to observe the individual over extended periods of time using an ethogram to record relevant behaviours, this is known as ethological coding (Highfill et al., 2010). This method is considered more reliable for species held in zoo environments as there are a higher number of factors which can influence the reliability of test situations. Ethological coding is also non-invasive and does not require any special circumstances or involvement from keepers (Watters & Powell, 2012). A combination of the two coding methods has also been used for a more eclectic approach (Bergvall et al., 2011). While some research has found high reliability of the coding behaviour methods (Highfill et al., 2010), the majority of studies often do not test for the reliability of behavioural coding.

While the two methods of personality assessment are often used synonymously, and frequently methods are chosen for convenience, it is possible that they do not harvest the same results (Highfill et al., 2010; Watters & Powell, 2012). The aim of this study was to compare the two methods of personality assessment in order to determine whether or not they are interchangeable methods of non-human animal personality assessment or if there is a significant difference in the consistency of results between the two. This study uses the two dimensions extraversion and neuroticism in order to investigate if different taxa, carnivores or ungulates, give more or less consistent results of animal personality assessment across the two methods.

Methods

Overview

Six zoo keepers from The Wildwood Trust (Herne Bay, Kent, United Kingdom), were asked to rate the personality traits and behavioural traits of 12 individuals they cared for in the form of a questionnaire. The same animals then were studied for measures of personality traits through an observational activity budget over the period of 20 days over the course of two months.

Each animal was assessed for two personality traits: neuroticism (N) and extraversion (E). The measures of animal personality were split into three categories: observational measures of personality (O), keeper scores of personality (KP) and keeper scores of behaviours (KB). In total each individual has six measures of personality; three for neuroticism and three for extraversion, as described in Table 1.

Table 1: Six measures of animal personality for each individual. Three measuring the dimension neuroticism, three measuring the dimension extraversion.

Acronym	Measure of Personality
ON	Observational measure of neuroticism
OE	Observational measure of extraversion
KPN	Keeper personality score for neuroticism
KPE	Keeper personality score for extraversion
KBN	Keeper behaviour score for neuroticism
KBE	Keeper behaviour score for extraversion

Animal and Keeper Subjects

Animal species studied included Eurasian brown bear (*Ursus arctos arctos*), Arctic fox (*Vulpes lagopus*), red fox (*Vulpes vulpes*), European pine marten (*Martes martes*), Eurasian otter (*Lutra lutra*), Eurasian wolf (*Canis lupus lupus*), red deer (*Cervus elaphus*), European bison (*Bison bonasus*), wild boar (*Sus scrofa*), Konik horse (*Equus ferus caballus*), Soay sheep (*Ovis aries*) and reindeer (*Rangifer tarandus*). One individual animal from each species was chosen from this range of carnivores and ungulates which were all native to the United Kingdom and housed at The Wildwood Trust. Six ungulate and six carnivore individuals were chosen due to distinctive characteristics which meant they could be distinguished from the rest of the individuals in the same enclosure in order to ensure the same animal was being

observed each time. Nocturnal animals were not used as the only access to the park was during public opening hours from 10:00 until 17:00.

The six keepers were chosen based on their relationship with the individual animals. Keepers at this particular organisation each have distinct sections of the zoo where they cared for the animals within them, therefore there was very little crossover between species except for the Eurasian brown bear. Keepers were ask to give informed consent and the research was also approved by the education department at The Wildwood Trust. Each keeper participant was numbered for anonymity.

Behavioural Links to Personality Dimensions

The personality dimension neuroticism has been referred to as "vulnerability to stress" (Gosling and John, 1999, Table 1). It has also been described using the following traits: anxious, fearful, nervous, and timid with the opposite end of neuroticism being: calm and stable (Goldberg, 1990, Table 1). Carlstead et al. (1999) found that chase and stereotypy behaviours were significantly correlated with one another and share the feature of frustration. They also found that fear can cause hesitancy in approach to other conspecifics, novel objects and new situations (timidity/anxiety) and the unlikeliness of pursuing social interactions, or activity in general. Sleep was also positively correlated with fear (ibid) as excessive inactivity was linked to animals in aversion situations.

The personality dimension extraversion has been referred to as sociable and active (Gosling and John, 1999, Table 1), also talkative and brave with the opposite end of extraversion being lethargic, unfriendly, quiet, and withdrawn (Goldberg, 1990, Table 1). Carlstead et al. (1999) discovered that individuals who were frequently in contact with others were also extraverted and approached people more readily; they were labelled as friendly. The Hominoid Questionnaire (Weiss et al., 2009) describes extraversion as affectionate, active, social and friendly with the opposite to extraversion being described as lazy, solitary and depressed. Based on these descriptions, the follow methods were used.

Observational Measures of Personality

All individuals were observed over a series of 20 days throughout August and September. Observational data was collected through the use of a generic ethogram (Table 2) which covered behaviours for all species. This ethogram was used in order to build activity budgets through focal animal sampling for each individual which included state and event behaviours as well as proximity to people and to conspecifics (Table 3), where applicable, at each time interval. Each observation period lasted ten minutes with a scan sample (Martin & Bateson, 1993) taken every 30 seconds, therefore there were 21 samples points per ten minute period including time 00. As the zoo was only open to the public from 10:00 until 17:00 all samples were taken between those times.

Each animal was sampled ten times (210 sample points) over the course of several days rather than just one animal per day to ensure they were observed over various circumstances, times and environmental conditions. Behaviours in the 'state' grouping were mutually exclusive as well as those within the 'event' grouping. There was a note section also to make notes of extra behaviours or environmental factors which may be relevant when defining the type of behaviour observed. If an individual

was classified as out of sight during a scan sample, proximity measures could only be taken if all of the other conspecifics in the enclosure were visible. The ethogram was designed to cover a broad range of behaviours across all species used and was based on previous studies of personality in non-human animals (Bremner-Harrison et al., 2004; Weiss et al., 2009) which in turn were based on the Five-Factor Model (Goldberg, 1990).

Each data collection sheet allowed for state and event behaviours to be marked at each time interval using the appropriate abbreviations to ensure quick recording, as well and human and conspecific proximities (Table 3) and room for extra notes. Time, date, weather conditions and visitor density were also accounted for.

Table 2: Generic behavioural ethogram with definitions of behaviours and abbreviations used during the activity budget. Behaviours were split into two categories, state and event, which were considered mutually exclusive within their categories.

State Behaviours	Description
Sleep (SL)	Lying with eyes closed
Stand (ST)	All limbs extended with feet on ground in upright position
Out of sight (OOS)	View of individual obscured by object or shelter
Lying (L)	Body in full contact with ground, head close to ground
Sit (SI)	Rear body touching ground with front upright
Self-groom (GS)	Using their own mouth or claws to lick, nibble or scratch their fur
Allogroom conspecific (GC)	Licking fur of another animal
Reciever of allogrooming (GR)	Another animal is licking individuals fur
Eating (E)	Ingests food, chewing food
Foraging (F)	Searching for food by sniffing ground and using feet to disturb substrate
Drinking (D)	Ingests water from water source
Pace (stereotypy) (P)	Repeated movements in a particular pattern
Walk (W) towards (WT) / away (WA) from conspecific	Slow forward locomotion
Run (R)	Fast forward locomotion
Case conspecific (C)	Fast forward locomotion following a conspecific

Event Behaviours	Description
Urinate (U)	Release of urine
Defecate (D)	Release of faeces
Vocalise (V)	Production of sound from individual
Aggression towards conspecific (AC)	Attack or attempt to attack another individual such as swipes and vocalisations
Victim of aggression by conspecific (AV)	On receiving end of an attack or an attempted attack by another individual
Lick object (L)	Tongue contact with object for maximum of 5 seconds
Sniff object (S)	Nose close to object and inhales
Scratch (SC)	Use of limb or object to rub against body part

Table 3. Proximity classifications and their descriptions and abbreviations. Proximity to conspecifics and people were noted at each time interval.

Proximity	Description
Far from conspecific (CF)	Two or more body lengths from conspecific
Nearby conspecific (CN)	Within two body lengths from conspecific
Touching conspecific (CT)	Passive body contact with conspecific
Far from people (PF)	Three or more body lengths from keeper/public
Nearby people (PN)	Within three body lengths from keeper/public
Touching people (PT)	Body contact with keeper/public

Questionnaire Methods

The keepers were asked to score each animal for personality traits (KP) but were also asked to score each animal for behaviour traits (KB) which have shown to be correlated with the personality traits. This was to demonstrate whether or not there was a consistency between what the keeper thought about the personality of the animals and how the keeper actually sees the animal behave. The participating keepers were given questionnaires according to the number of individuals they were responsible for scoring. Half of the questionnaires were given out as behaviour questions first and then personality questions second and half were given the opposite way around in order to minimise the bias of order effects.

Each trait was assessed on a five point Likert scale where ‘1’ being that the individual never displays this behaviour/personality trait and ‘5’ being that the individual consistently displays this behaviour/personality trait. The instructions asked the keepers to score based on overall impressions rather than specific instances or anecdotal evidences. It was also asked that the keepers not discuss their responses to the questionnaires with any other keepers.

The personality aspect of the questionnaire contained 11 traits each followed by a short description of what was meant by the trait in general in order to accommodate each species (Table 4). The behaviour aspect of the questionnaire contained seven adjectives of behaviour each followed by a short description of what the behaviour would look like, again the behaviours were generalised in order to account for differences between species (Table 5). These personality trait descriptions were taken from Goldberg’s Five-Factor Model (1990, Table 1). The behaviours corresponded with behaviours recorded during the activity budget.

Table 4. Personality traits used in keeper personality questionnaire and their corresponding personality dimension category.

Personality Trait and Description	Personality Dimension
Friendly to conspecifics: touches other individuals in a passive manner	Extraversion
Friendly to keepers: touches keepers in a passive manner	Extraversion
Sociable: spends time with other individuals within enclosure	Extraversion

Fearful of keepers: does not approach keepers, will avoid them as much as possible and put a lot of distance between them	Neuroticism
Fearful of public: will avoid fences and areas of enclosure which is prone to visitors	Neuroticism
Hostile: initiates fighting behaviour towards conspecifics and/or keepers	Neuroticism
Aggressive to keepers: acts hostile towards keepers	Neuroticism
Aggressive to conspecifics: acts hostile towards conspecifics or others within enclosure	Neuroticism
Solitary: spends a lot of time away from others in the enclosure	Neuroticism
Energetic: spends a lot of time active	Extraversion
Calm: not easily disturbed by environmental change (e.g. increased noise)	Extraversion

Table 5. Behaviour traits used in the keeper behaviour questionnaire and their corresponding personality dimension category.

Behaviour Trait and Description	**Personality Dimension**
Vocal: vocalises in response to people and/or conspecifics	Neuroticism
Stereotypic: repetitive behaviour with no obvious purpose (e.g. pacing in specific areas)	Neuroticism
Chase: runs towards/behind other individuals within the enclosure	Neuroticism
Active: locomotion (e.g. walking, pacing, patrolling, running)	Extraversion
Inactive: stationary (e.g. resting, sleeping, laying)	Neuroticism
Avoidance: moves away from other individuals once they are in close proximity or does not allow others to be in close proximity in the first place	Neuroticism
Allogroom: licks fur of other individuals within enclosure	Extraversion

Ethical Statement

Human participants gave informed consent before participating in any stage of the study. Those which did not give informed consent were never asked to provide any information about themselves or the individuals in their care. The information provided gave an outline of the aims of the study, the requirements of the participants and stated that their employer, The Wildwood Trust, had approved the research and that ethical approval to conduct the research had been given by the University of Plymouth. The participants were also told that their responses would be confidential and they could withdraw from the study at any time by not returning their questionnaires. They were also given a contact email address they could use if they had any queries or concerns about the study. Humans under the age of 18 were not asked to participate. Ethical approval for the use of animals within this study was not a requirement as there was no contact or manipulation of the animals or their environment which was also supported by the University of Plymouth. Necessary risk assessments also took place.

Data Analysis

Observational Data

Principle components analysis (using the statistical analysis software SPSS) was used in order to condense the number of traits into two sets of separate traits for the observation data (O). The observed measures used for the analysis were: active, vocal, walk away (WA), all proximity measures to people and conspecifics (Table 3), stereotypic behaviour, aggression, and victim of aggression – all of which were produced as a percentage of proportion of time spent exhibiting those behaviours (number of occurrences divided by total sample number: 210).

Principle components analysis extracted two components with Eigenvalue over two (Table 6). Component 1 describes traits which scored high in activity, low in aggression, high in close proximity to people, low in proximity to conspecifics and high on the receiving end of aggression; this component was labelled 'extraversion' (OE). Component 2 describes traits which scored low in activity, high in aggression, low in proximity to conspecifics and people, high in vocal and high in visibility; this component was labelled 'neuroticism' (ON).

Table 6. Account of the principle components extracted by analysis of the activity budgets, '+' symbolises a high score while '-' symbolises a low score

Component	Eigenvalue	% of Variance	Traits	Personality Trait Label
Component 1	3.866	29.736	+ Activity - Close proximity to conspecifics + Close proximity to people + Victim of aggression	Extraversion
Component 2	2.655	20.423	- Activity + Visible - Touching conspecifics - Close proximity to conspecifics + Vocal + Aggressive	Neuroticism

As stated previously, behaviour traits which are low in activity, low in social interactions and social proximity and high in aggression, frustration and fear are correlated with the personality dimension neuroticism (Goldberg 1990; Carlstead et al. 1999; Gosling & John 1999). Also behaviour traits which are high in activity, close proximity to people and friendly are correlated with the personality dimension extraversion (*ibid*).

Keeper Questionnaire
The scores from the personality aspect of questionnaire were divided into two groups, extraversion and neuroticism, as shown in Table 4. These scores were then averaged to find a mean score per individual for each group, this mean result formed the keeper personality scores for neuroticism (KPN) and extraversion (KPE).

Similarly, the scores from the behaviour aspect of the questionnaire were also divided into the two personality groups shown in Table 5. These scores were also averaged to find a mean per individual for each group which then formed the keeper behaviour score for neuroticism (KBN) and extraversion (KBE).

Statistical Analysis
Normality tests concluded that four out of the six data sets (ON, KBN, OE and KPE) followed the trends of normal data. However due to a couple of the data sets (KPN and KBE) not following normal data trends, non-parametric measures were used. Spearman's Rank correlation was used to determine whether or not there was a relationship between the observed measured personality traits (OE and ON, calculated by principle components analysis using the activity budgets), the keeper personality scores (KPE and KPN) and the keeper behaviour scores for both personality dimensions, extraversion and neuroticism. Mann-Whitney tests were used to determine if there was a significant difference in score between the independent groups of taxa across all six measures of personality.

Results
A significant correlation was found between KPE and KBE (Table 7, Figure 3) however no significant correlations were found between OE and KPE (Figure 1, Table 7) or OE and KBE (Table 7). Likewise, no significant correlations were found between ON and KPN (Figure 2, Table 8), ON and KBN or KPN and KBN for neuroticism (Table 8).

Table 7. Spearman's rank correlation (rs) for combined carnivores and ungulates (N = 12) for personality trait extraversion, where OE = observational measure of extraversion, KPE = keeper personality score for extraversion and KBE = keeper behaviour score for extraversion. (*significant values)

	OE	**KPE**
KPE	-0.120 *P* = 0.710	
KBE	-0.14 *P* = 0.965	0.584* *P* = 0.046

Table 8. Spearman's rank correlation (rs) for combined carnivores and ungulates (N = 12) for personality trait neuroticism, where ON = observational measure of neuroticism, KPN = keeper personality score for neuroticism and KBN = keeper behaviour score for neuroticism.

	ON	**KPN**
KPN	0.319 *P* = 0.313	
KBN	-0.112 *P* = 0.728	0.030 *P* = 0.926

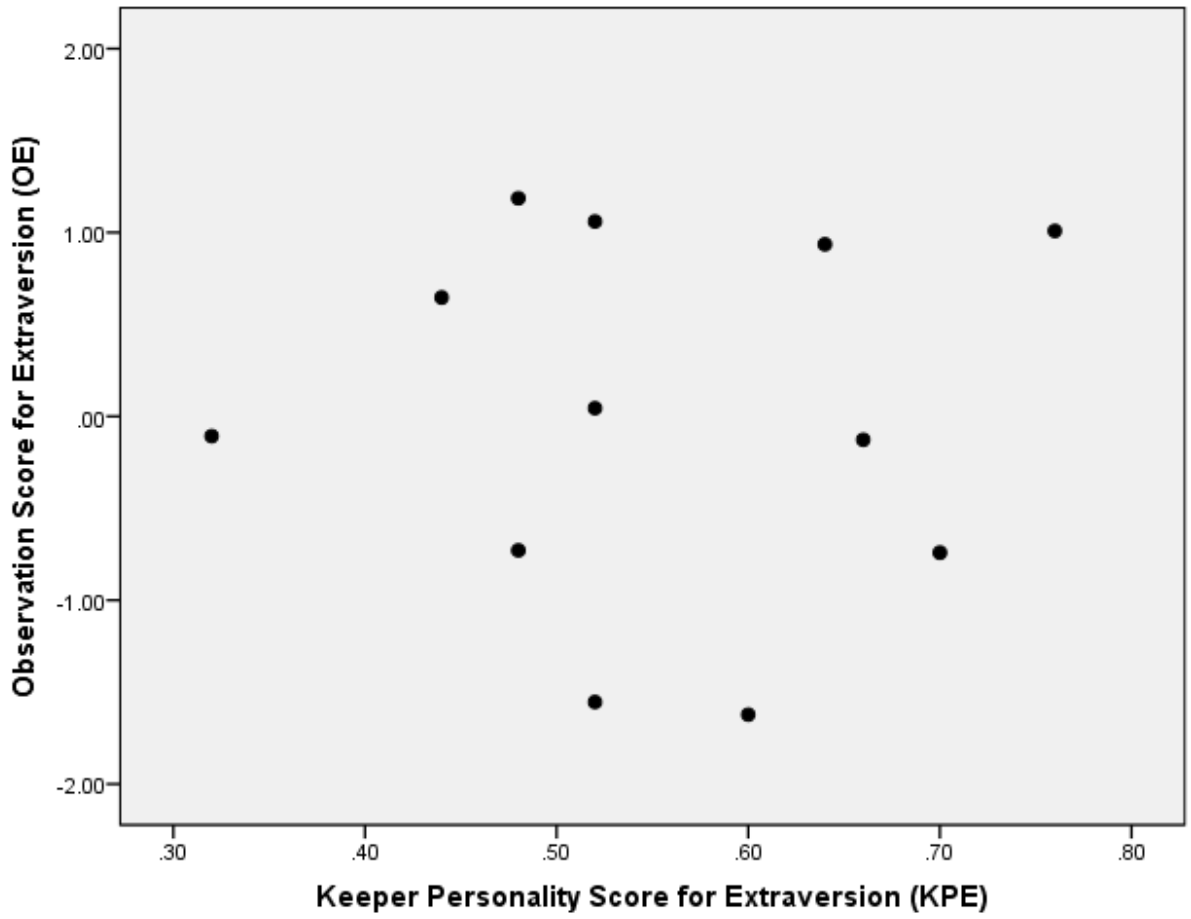

Figure 1: Observational personality measure of extraversion (OE) (derived from the principle component analysis score) compared with the keeper personality score for extraversion (KPE) based on the personality trait questionnaire scores.

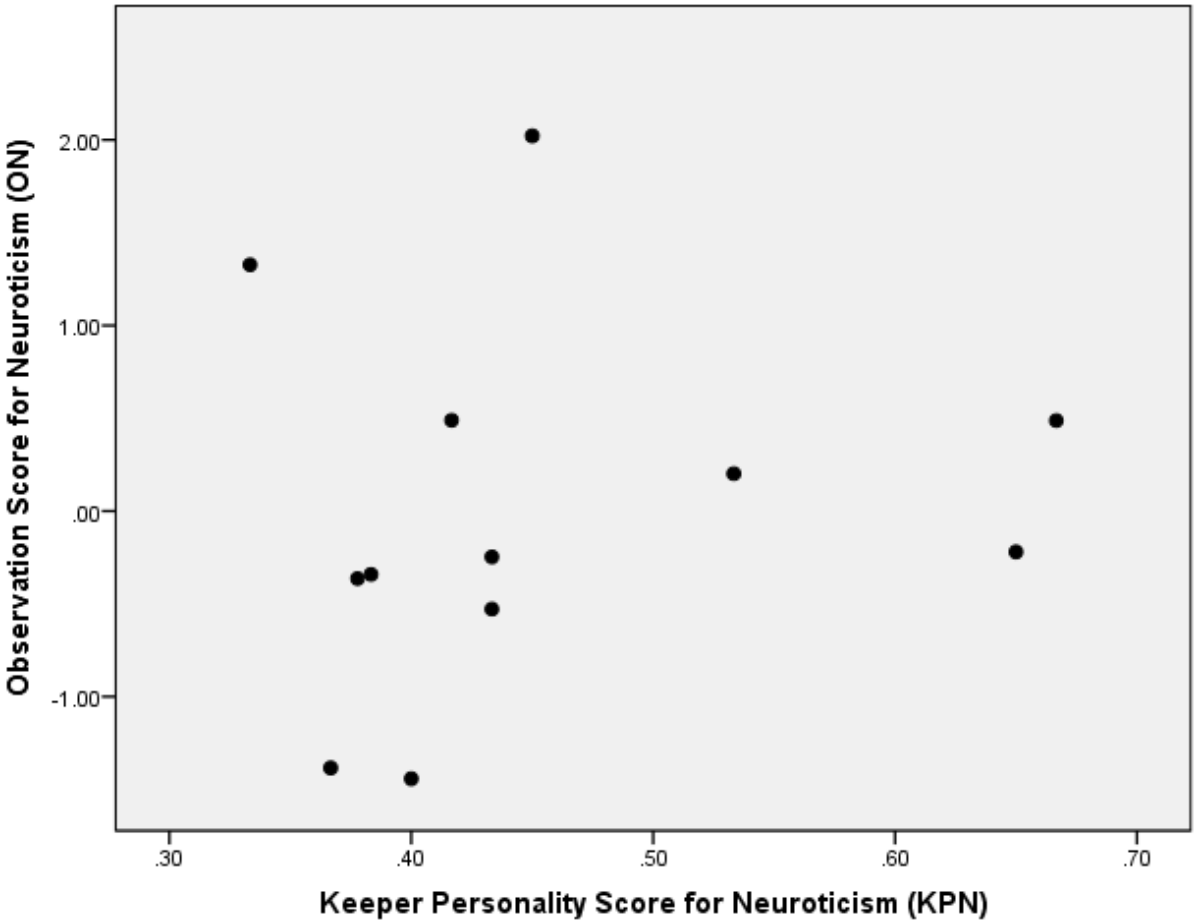

Figure 2: Observational personality measure of neuroticism (ON) (derived from the principle component analysis score) compared with the keeper personality score for neuroticism (KPN) based on the personality trait questionnaire scores.

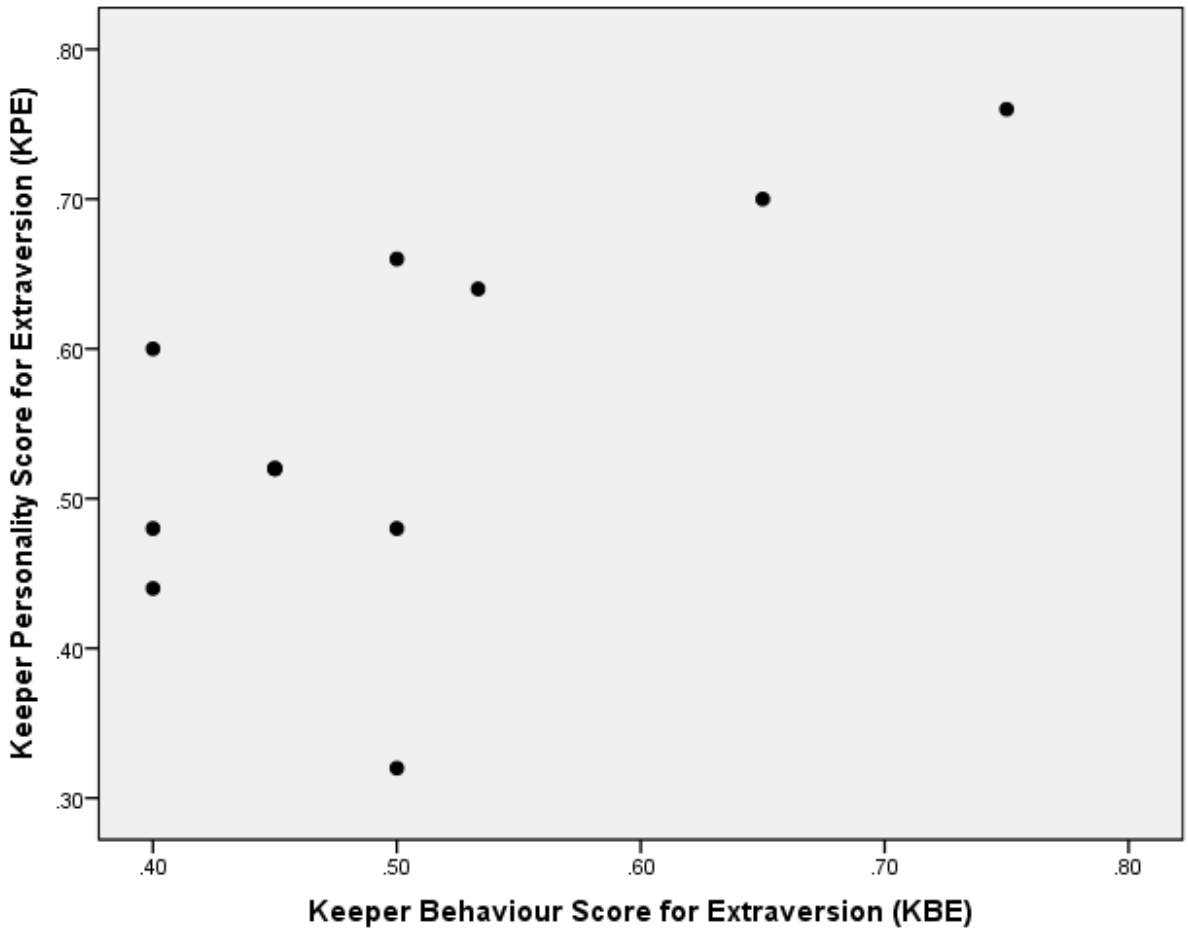

Figure 3. Keeper personality trait score for extraversion (KPE) compared with the keeper behaviour trait score for extraversion (KBE) based on the personality and behaviour scores from the questionnaire.

Ungulates Compared with Carnivores

No significant relationships were found between the measures of neuroticism (Table 9) or extraversion (Table 10) when separated into carnivores and ungulates.

Table 9. Spearman's rank correlation (rs) for carnivores (N = 6) and ungulates (N = 6) for personality trait neuroticism, ON = observational measure of neuroticism, KPN = keeper personality score for neuroticism and KBN = keeper behaviour score for neuroticism.

	ON	**KPN**
KPN		
Carnivores	0.174	
	P = 0.742	
Ungulates	0.543	
	P = 0.266	
KBN		
Carnivores	0.577	0.464
	P = 0.231	*P* = 0.354
Ungulates	-0.031	-0.464
	P = 0.954	*P* = 0.354

Table 10. Spearman's rank correlation (rs) for carnivores (N = 6) and ungulates (N = 6) for personality trait extraversion, where OE = observational measure of extraversion, KPE = keeper personality score for extraversion and KBE = keeper behaviour score for extraversion.

	OE	**KPE**
KPE		
Carnivores	-0.486 *P* = 0.329	
Ungulates	-0.516 *P* = 0.295	
KBE		
Carnivores	-0.334 *P* = 0.518	0.698 *P* = 0.123
Ungulates	0.062 *P* = 0.908	0.492 *P* = 0.322

There was no significant difference in score found between extraversion and neuroticism for the two taxa across all six measures of personality and both personality dimensions (Table 11).

Table 11. Mann-Whitney test results when comparing the taxa, carnivores and ungulates, as the variable for each measure of personality.

	Mann-Whitney *U*	***N*$_1$**	***N*$_2$**	***P***
ON	16	6	6	0.749
KPN	11	6	6	0.261
KBN	12	6	6	0.334
OE	14	6	6	0.522
KPE	15.5	6	6	0.686
KBE	10	6	6	0.191

Discussion

The primary objective of this study was to determine whether behavioural coding and the rating of traits give consistent measures of animal personality. This study found no significant relationship found between the observational measures of personality (OE and ON) and the keeper scores for personality (KPE and KPN) for both traits, extraversion (Table 7, Figure1) and neuroticism (Table 8, Figure 2), which was clearly demonstrated when taxa where analysed separately (Table 9 & 10). This demonstrates that the two methods of personality assessment did not provide consistent results or valid analysis of the two personality dimensions, extraversion and neuroticism.

There was no significant relationship found between the observational measures (OE and ON) and the behaviour scores the keepers gave (KBN and KBE) (Table 7 & 8). This indicates that the keepers were not accurate in predicting the frequency of time their animals spent displaying certain behavioural traits linked to the two

personality dimensions. Additionally, when comparing keeper personality scores (KPE and KPN) with keeper behaviour scores (KBN and KBE), a significant correlation was found for the dimension extraversion (Table 7, figure 3). This indicates that the keepers were consistent in their scoring for both behavioural and personality measures of extraversion. Conversely this relationship was not demonstrated for neuroticism (Table 8) or when ungulates and carnivores where analysed independently (Table 9 & 10). Other research has found that extraversion and neuroticism have the highest inter-rater reliability and agreement for non-human animals (John & Robins, 1993; Morris et al., 2002). This is apparent due to the two dimensions being more observable than other dimensions and their associated behaviours (Funder & Dobroth, 1987). Although extraversion and neuroticism are the two most visible dimensions, extraversion is deemed the most visible with highest inter-rater agreement and neuroticism is considered to be less visible and therefore rated less accurately (*ibid*). This may explain why there was a significant correlation between KPE and KBE, but no significant relationship found between KPN and KBN, because neurotic behaviour is harder to identify than extraverted behaviour.

Neither taxa were more extraverted or neurotic than one another across all measures of personality (Table 11). While there are no similar cross-taxa personality studies to validate or refute this result, there is some evidence to suggest that aggressiveness (linked to neuroticism) is correlated with anti-predator behaviour (Huntingford, 1976; Riechert & Hedrick, 1993) in prey species. This would provide evidence to suggest that ungulates would, on average, have a higher neuroticism score than carnivores which was not demonstrated in this study. However, it is unclear how captive environment settings influence anti-predator behaviour in individuals which have been bred for zoological purposes (West et al., 2018). In order to validate the finding that there was no difference in extraversion and neuroticism between taxa, future research would be necessary with larger sample groups and a higher number of keepers in order to investigate inter-rater reliability also. As there is little research into cross-species personality comparisons, a continuation of this research would be interesting in order to discover how significant personality differences are between taxa.

The ethogram used in this study was simplistic in its variety of behaviours, this was an attempt to cover a range of species, and previous research has shown that complex ethograms are unnecessary and that reliable behaviour differences can be measured using more basic ethograms (Reale et al., 2000). However in this instance the ethogram was not designed for one specific species, a simple ethogram may be enough for a single species but a more complex, species specific ethogram may have helped in the accuracy of the representation of individual animal personality in this circumstance. For example a tailored ethogram per species may have improved accuracy in recording the two dimensions.

As multiple observers and raters were not used per individual, the reliability of the tests cannot be investigated. Therefore it is a possibility that the observational data (OE and ON) may not be accurate in assessment. One factor which may contribute to the inaccuracy of the measures could be that the individuals were not observed for long enough over a sufficient range of circumstances to allow for observation of a variety of behaviours. When using the ethological coding method, it has been suggested that adequate measures of behavioural tendencies can arise from as little

as ten observation points at 15 minute durations spread over as many contexts as possible (Watters & Powell, 2012). Unfortunately this study consisted of only ten, ten minute sampling periods which may reduce the reliability of the personality assessments created from the observational data. It is also a possibility that the keeper scores from the questionnaires are also inaccurate. Many of the individuals had only one keeper to rate them. A few species had two or more keepers rate them therefore their keeper scores (KP and KB) were an average of those scores; unfortunately the inter-rater reliability cannot be tested on such a small sample size.

Ethological coding of behaviour is believed to be a skill easier to acquire than the rating of traits, as ratings require a more in depth knowledge of both the individuals and the species (Watters & Powell, 2012). This was demonstrated in a study by Highfill et al. (2010) where the inter-rater reliability for coding behaviour was significantly higher than the inter-rater reliability of trait ratings for Garnett's bush babies (*Otolemur garnettii*). Conversely, Uher (2013) found that researchers with little experience in observing and recording animal behaviour were able to reliably rate macaque personality on a level comparable to professionals who were very familiar with the macaques. In many cases inter-rater reliability for the rating of traits usually depends on the type of experience the rater has had with the animals (Highfill et al., 2010). This research, if conducted again, would benefit from a greater number of raters per individual and also information surrounding the nature of the relationships between rater and individual being rated, such as length of time working with the individual or species.

Ultimately the most reliable way to create a valid measure of animal personality dimensions would be to use a combination of multiple techniques (Highfill et al., 2010). While using both coding and rating methods would provide a deeper insight into individual personality, it would also be more time consuming, which may be the reason why there is so little research into the effectiveness of a multi-method approach and why they are a rarity in animal personality research. Carlstead et al. (1999) used a combination of both techniques, rating and coding in test situations, to determine a relationship between breeding success and personality in black rhinoceros (*Diceros bicornis*). They were able to successfully validate the cross-institutional keeper ratings of differences in behavioural traits specific to the black rhinoceros using both methods of animal personality assessment, which were then linked to reproductive performance. Similarly, Powell & Svoke (2008) used a multi-method approach, combining behavioural coding in test situations and trait rating, to assess the personalities of giant pandas (*Ailuropoda melanoleuca*) in captivity. They were able to demonstrate some qualitatively similar results at the individual level, which were mainly attributed to sex differences, and were able to create individual behaviour profiles of the animals. Both of these studies demonstrate that in order to gain useful insight into personality of specific species, it may be worth investing a greater amount of time into conducting the assessment.

However, single methods of coding behaviour in test situations can be very useful, rapid assessments of personality in situations that do not allow for laborious methods of personality assessment. These methods have, for example, been used on mink farms in order to breed mink that are less fearful and aggressive and more exploratory in nature when reacting to a stick (novel object) test (Hansen & Moller, 2001). Selecting for less fearful mink allows for a reduction in stress responses to

their environmental conditions and in turn, welfare improvement (*ibid*). Methods used to assess animal personality are often situational. While applying a multi-method technique would give the most accurate measure of personality and is the most useful in conservation efforts for example, there are some situations which do not require such rigorous profiles of individual personality and may rely on one method alone to give valuable insight into temperament to provide the best welfare standards possible.

Personality assessments have become increasingly more important in regards to conservation efforts with evidence that some vertebrate personality traits, particularly exploration, aggression, boldness and risk-taking behaviour, have shown to be heritable through genetic studies of animal personality (Van Oers et al., 2005). The importance of an accurate animal personality assessment is demonstrated in Bremner-Harrison et al. (2004) where captive-bred swift foxes (*Vulpes velox*) were assessed for boldness before being released into the wild through a reintroduction programme. The foxes were tracked and those who measured highest for boldness died within the first six months, with more fearful individuals performing better in the wild. This demonstrates how aspects of animal personality can be used in order to assess which individuals are best for use in successful conservation programmes. Analysis of personality and behaviour of captive individuals has been validated through studies of their wild counterparts (Herborn et al., 2010) which confirms that analysis of captive animal personality is appropriate when considering release programmes.

Conclusions

It can be concluded that this study demonstrates the complex nature of animal personality assessments. While no significant data was found to imply that the two methods are consistent, this study is one of the first that assess different groups of taxa with exactly the same methodology and found inconsistent results. While no differences between the taxa were established, the data obtained from this investigation has the ability to aid future research into cross-taxa comparisons of personality dimensions and the methods by which the information is acquired. It also provides support for a multi-method approach for analysis of non-human animal personality, with data showing inconsistent results between the individual methods – behavioural coding and the rating of traits.

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References

Andersson, A., Laikre, L. & Bergvall, U. (2014). Two shades of boldness: novel object and anti-predator behaviour reflect different personality dimensions in domestic rabbits. *Journal of Ethology*, 32, 123-136.

Bergvall, U., Schäpers, A., Kjellander, P. & Weiss, A. (2011). Personality and foraging decisions in fallow deer, *Dama dama*. *Animal Behaviour*, 81, 101-112.

Biro, P. (2012). Do rapid assays predict repeatability in labile (behavioural) traits? *Animal Behaviour*, 83, 1295-1300.

Borell, C., Kulik, K. & Widdig, A. (2016). Growing into the self: the development of personality in rhesus macaques. *Animal Behaviour*, 122, 183-195.

Bremner-Harrison, S., Prodohl, P. & Elwood, R. (2004). Behavioural trait assessment as a release criterion: boldness predicts early death in a reintroduction programme of captive-bred swift fox (*Vulpes velox*). *Animal Conservation*, 7, 313–320.

Capitanio, J. (1999). Personality dimensions in adult male rhesus macaques: prediction of behaviours across time and situation. *American Journal of Primatology*, 47, 299–320.

Carlstead, K., Mellen, J. & Kleiman, D. (1999). Black rhinoceros (*Diceros bicornis*) in U.S. zoos: I. Individual behavior profiles and their relationship to breeding success. *Zoo Biology*, 18, 17–34.

Funder, D. & Dobroth, K. (1987). Differences between traits: properties associated with interjudge agreement. *Journal of Personality and Social Psychology*, 52, 409-418.

Gartner, M. & Weiss, A. (2013). Scottish wildcat (*Felis silvestris grampia*) personality and subjective well-being: Implications for captive management. *Applied Animal Behaviour Science*, 147, 261– 267.

Goldberg, L. (1990). An alternative "description of personality": the big-five factor structure. *Journal of Personality and Social Psychology*, 59, 1216-1229.

Gosling, S. (2001). From mice to men: what can we learn about personality from animal research? *Psychological Bulletin*, 127, 45-86.

Gosling, S. (2008). Personality in non-human animals. Social and Personality *Psychology Compass*, 2, 985–1001.

Gosling, S. & John, O. (1999). Personality dimensions in nonhuman animals: a cross-species review. *Current Direction in Psychological Science*, 8, 69-75.

Gosling, S. & Vazire, S. (2002). Are we barking up the right tree? Evaluating a comparative approach to personality. *Journal of Research in Personality*, 36, 607-614.

Hansen, S. & Moller, S. (2001). The application of a temperament test to on-farm selection of mink. *Acta Agriculturae Scandinavica*, 30, 93–98.

Herborn, K., Macleod, R., Miles, W., Schofield, A., Alexander, L. & Arnolda, K. (2010). Personality in captivity reflects personality in the wild. *Animal Behaviour*, 79, 835-843.

Highfill, L., Hanbury, D., Kristiansen, R., Kuczaj, S. & Watson, S. (2010). Rating vs. coding in animal personality research. *Zoo Biology*, 29, 509–516.

Huntingford, F. (1976). The relationship between anti-predator behaviour and aggression among conspecifics in the three-spined stickleback, *Gasterosteus Aculeatus. Animal Behaviour*, 24, 245-260.

King, J. & Figueredo, A. (1997). The Five-Factor Model plus dominance in chimpanzee personality. *Journal of Research in Personality*, 31, 257-271.

John, O. & Robins, R. (1993). Determinants of interjudge agreement on personality traits: the Big Five domains, observability, evaluativeness, and the unique perspective of the self. Journal of Personality, 61, 521-551.

Martin, J. (2005). The influence of rearing on personality ratings of captive chimpanzees (*Pan troglodytes*). *Applied Animal Behaviour Science*, 90, 167–181.

Martin, P. & Bateson, P. (2007). *Measuring behaviour: an introductory guide*. (3rd ed.). Cambridge: Cambridge University Press, (Chapter 5).

Morris, P., Gale, A. & Duffy, K. (2002). Can judges agree on the personality of horses? *Personality and Individual Differences*, 33, 67-81.

Natolia, E., Sayb, L., Cafazzoc, S., Bonannid, R., Schmidc, M. & Pontierb, D. (2005). Bold attitude makes male urban feral domestic cats more vulnerable to feline immunodeficiency virus. *Neuroscience and Biobehavioral Reviews*, 29, 151–157.

Powell, D. & Svoke, J. (2008). Novel environmental enrichment may provide a tool for rapid assessment of animal personality: a case study with giant pandas (*Ailuropoda melanoleuca*). *Journal of Applied Animal Welfare Science*, 11, 301-318.

Reale, D., Gallant, B., Leblanc, M. & Festa-Bianchet, M. (2000). Consistency of temperament in bighorn ewes and correlates with behaviour and life history. *Animal Behaviour*, 60, 589–597.

Riechert, S. & Hedrick, A. (1993). A test of correlations among fitness-related behavioural traits in the spider, *Agelenopsis aperta (Aranea, Agelinadae). Animal Behaviour*, 46, 669-675.

Uher, J., Werner, C. & Gosselt, K. (2013). From observations of individual behaviour to social representations of personality: Developmental pathways, attribution biases, and limitations of questionnaire methods. *Journal of Research in Personality*, 47, 647–667.

Van Oers, K., de Jong, G., van Noordwijk, A., Kempenaers, B. & Drent, P. (2005). Contribution of genetics to the study of animal personalities: a review of case studies. *Behaviour*, 142, 1185-1206.

Watters, J. & Powell, D. (2012). Measuring animal personality for use in population management in zoos: suggested methods and rationale. *Zoo Biology*, 31, 1–12.

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

West, R., Letnic, M., Blumstein, D. & Moseby, K. (2018). Predator exposure improves anti-predator responses in a threatened mammal. *Journal of Applied Ecology*, 55, 147-156.