Studying primate personality in zoos

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Studying primate personality in zoos: implications for the management, welfare and conservation of great apes

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As we face the Anthropocene extinction, many species are threatened or becoming so, and great ape species are no exception (all are Endangered or Critically Endangered). As humans work to combat this trend, research on every aspect of the lives of animals is vital. One area of research that has the potential to be particularly useful is the study of personality. Zoological institutions offer a unique opportunity for research on personality in non-human primates, with knowledgeable staff, consistency in environment, accessibility of a variety of species and the possibility to have large sample sizes to provide generalizability. Here, we offer a perspective on how zoos have contributed to the personality literature, how the personality literature can aid animal management and how much further such research can continue, with implications for both welfare and conservation.

Key-words: conservation; genetics; great apes; personality; primates; research; welfare; zoos.

INTRODUCTION

All taxa of great apes are threatened (IUCN, 2017) and it is imperative that those who work to conserve such species research all aspects of their lives to improve the information and resources available to expand our knowledge. The goal here is to discuss how research in zoos has contributed to our understanding of the personality of great apes, and how work on primate personality can contribute to the goals of zoos and to the welfare of the animals in their care. The advantages of studying personality, and probably other behavioural phenomena, in primates that are housed in zoos (rather than those in the field or laboratory) are described. The authors will discuss how zoos can and have contributed to the literature about primate personality, deliberate about the ways in which such knowledge can facilitate management of great apes in zoos, and consider how future research might have implications for welfare and conservation.

STUDIES INTO THE PERSONALITY OF PRIMATES

The study of personality in non-human primates has been ongoing since at least the 1930s, although it was only since around the 1990s that it attracted the attention of more than a handful of researchers (Whitham & Washburn, 2017). The early research included studies of Chimpanzees *Pan troglodytes* in which personality was assessed using behavioural measures and ratings (Crawford, 1938; Hebb, 1946a,b, 1949). These studies tested whether subjects displayed individual differences in their behaviour, and in their emotional and cognitive tendencies. The various studies

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assessed whether these differences were consistent across raters and/or stable over time, and whether groups of traits defined personality dimensions. Further research included a study of Olive baboons *Papio anubis* in Nairobi National Park, Kenya (Buirski *et al.*, 1973), a study of Chimpanzees at Gombe National Park (Buirski *et al.*, 1978) and multiple studies of Rhesus macaques *Macaca mulatta* (Chamove *et al.*, 1972; Stevenson-Hinde & Zunz, 1978; Stevenson-Hinde *et al.*, 1980a,b). In addition to testing whether there were stable individual differences in personality traits and a clustering of traits that signalled the presence of underlying dimensions, these studies examined sex and age differences in personality, and associations between personality and rank.

The next burst of investigations into the personality of primates, which started during the 1990s and is still ongoing, included studies of primates in laboratory colonies, in the wild and those living in zoos. Non-invasive research in zoos and sanctuaries has contributed to our understanding of the biological bases of personality and its consequences, as we will discuss throughout this article. Basic research tends to be associated more with that conducted at primate research centres or similar facilities and, increasingly, in the field. However, studies of zoo-living primates are growing in number and include work on the genetics of personality, personality phylogeny, and the associations between personality and both physical and psychological health.

Genetics of personality

It is possible to examine the degree to which personality differences between individuals are attributable to genetic differences and the degree to which non-genetic influences are responsible for these same personality differences (Plomin *et al.*, 2013). Studies of animals bred for higher or lower levels of personality traits (e.g. anxiety) and studies that compare differently related individuals (e.g. monozygotic and dizygotic twins) have found that genetic differences in personality account for around half of the variation in personality among individuals (Bouchard & Loehlin, 2001). These twin studies and studies of non-twin human siblings have also found that the non-genetic variation is attributable to within-family effects (Bouchard & Loehlin, 2001). It is not the characteristics of the family environment in which one has grown up that make humans differ from one another, but environmental influences that have their effect on one child but not another. In other words, whether people grew up in rich, poor or middle-class households, contributes minimally, if at all, to personality differences among individuals; however, the friends that one child had that the other child did not have might very well lead to differences in personality (Harris, 1998).

Although the social structures of non-human primate species differ from one another and from human social structures, it is possible to conduct quantitative genetic studies. The pedigrees of many zoo-housed primates are important to maintain and promote genetic diversity (Glatson, 1986; Goossens *et al.*, 2002). By analysing these pedigrees, it is possible to determine the extent to which genetic or environmental influences are responsible for personality variation. Pedigrees and other information can be used to test the degree to which closely related individuals are more or less similar and whether sharing a mother or an enclosure is related to how similar individuals are to one another (Kruuk, 2004; Wilson, A. J., *et al.*, 2010).

To date, although there have been few genetic studies in zoo populations, the results resemble those found in humans and non-primate species. Research on zoo-housed Chimpanzees (Weiss *et al.*, 2000; Wilson, V. A. D., *et al.*, 2017), orangutans *Pongo* spp (Adams *et al.*, 2012) and Bonobos *Pan paniscus* (Staes *et al.*, 2016) has indicated that personality variation appears to be partly related to genetic differences between individuals and partly related to

the influences of environmental effects that operate at the within-zoo or within-family level. At the time of writing, no comparable study has been conducted on gorillas *Gorilla* spp.

Some genetic studies involve the attempt to find genes that are related to specific personality traits. In primates, these studies are presently limited to tests of whether 'candidate genes' are related to personality variation, thus resembling early attempts to find genes for human personality traits (e.g. Reif & Lesch, 2003). Studies of Chimpanzees living at Yerkes National Primate Research Center (Atlanta, GA, USA) (Hopkins *et al.*, 2012; Latzman *et al.*, 2015), and those living mostly in zoos, research centres and a sanctuary in Japan, amounting to 129 Chimpanzees including 19 that lived at a sanctuary in Guinea (Wilson, V. A. D., *et al.*, 2017), found evidence that versions of a gene for receptors for the hormone vasopressin are associated with the personality dimension Conscientiousness, which describes how tame and predictable individuals are [see Staes *et al.* (2016) for a similar finding in Bonobos]. However, the effects of single genes are very small, typically accounting for <1% of trait variation. Therefore, these studies are rare in non-human primates and in humans the findings often do not replicate (Munafò *et al.*, 2003). In response to the growing awareness that many earlier findings may have been false positives, molecular genetic studies of human personality traits have been turning towards studies that involve examining the effects of a vast number of genes in samples, often comprising 100 000 or more participants.

Personality phylogeny

The study of personality phylogeny answers questions about why individuals of one species can be classified along a specific personality dimension whereas those of another species cannot. A related question is why some personality differences are described by one dimension in one species and multiple dimensions in another. Phylogenetic studies have been used to help clarify the evolution of personality in primates. Such studies have also provided a clearer understanding of personality evolution in humans, the following example of which is informative. Human personality varies along five dimensions: Neuroticism, Extraversion, Openness to Experience, Agreeableness and Conscientiousness (Digman, 1990). Several explanations for why human personality is constituted by these dimensions have been put forward. However, many of these explanations are based on scenarios that are unique to humans or, at the very least, unique to social species. Searching for similar personality dimensions in species that are unlikely to encounter these evolutionary scenarios is a 'strong test', as defined by Platt (1964), of the plausibility of any such explanation (Weiss, 2018). For example, Extraversion and Agreeableness are often linked to evolutionary scenarios partly or wholly centring on human sociality and altruism, respectively (e.g. Nettle, 2006). The fact that similar dimensions emerge in a semi-solitary great ape (orangutans), suggests that these dimensions reflect the workings of other selective pressures (Weiss & King, 2015).

Association between personality and physical and psychological health

Studying great apes in zoos has provided insight into the associations between personality and psychological and physical well-being. A study of 128 Chimpanzees from 13 different zoos found that individuals rated higher in subjective well-being had personality profiles that characterized them as lower in traits related to Neuroticism (high Dominance in this case) and higher in Extraversion (King, J. E., & Landau, 2003). In humans, the personality dimensions Extraversion and Neuroticism are related to higher and lower subjective well-being, respectively (DeNeve & Cooper, 1998; Steel *et al.*, 2008). Another study of Chimpanzees found that the association between

Dominance and subjective well-being was attributable to common genetic effects (Weiss *et al.*, 2002). It would appear that the genes associated with Dominance differences were also associated with subjective well-being differences. Later studies of primates in zoos and other settings have found similar associations between personality and subjective well-being (Weiss *et al.*, 2006, 2011; Robinson *et al.*, 2016). Likewise, the genetic association between these personality dimensions and subjective well-being has been found in a pedigree-based study of zoo-living orangutans (Adams *et al.*, 2012), as well as in human twin and sibling studies (Weiss *et al.*, 2008; Hahn *et al.*, 2013), and in a molecular genetic study of humans (Weiss *et al.*, 2016).

The links between personality and physical well-being have not been well studied in zoo research, although they are exceptionally well-documented in humans (Deary *et al.*, 2010). One exception is a study carried out in the 1990s into Gorilla *Gorilla gorilla* personality, assessing 298 captive individuals over 1 year of age to create a 'Gorilla Behavior Index' using behaviourally defined adjectives (Gold & Maple, 1994). Following common factor analysis, four factors were identified: Extroverted (henceforth 'Extraversion' and 'Extraverted'), Dominant, Fearful and Understanding. In a follow-up study carried out more than 18 years later, it was found that Gorillas rated higher on Extraversion lived longer lives than their more introverted counterparts, an effect that could not be explained by demographic information or husbandry practices (Weiss *et al.*, 2013). Knowing this type of information could inform current veterinary care or end-of-life decisions. Suggestions on how to use personality in care have been made (Deary *et al.*, 2010) and most of these are also applicable to animals (Gartner & Weiss, 2013), including heightened surveillance for those with traits related to earlier mortality; the development of specific, individual intervention strategies; targeted drug treatments; and improved relationships between patients – or animals – and health-care practitioners – or vets.

BEHAVIOUR, MANAGEMENT AND CONSERVATION

Primates are the most studied animals in zoos (Melfi, 2009). The largest focus of this research in British and Irish zoos is on social behaviour, while in American zoos the focus is on reproduction and endocrinology (Melfi, 2005). In Europe, the United States and Japan there have been a large number of studies on primate cognition (Hopper, 2017). However, very little research is carried out on personality, and even less on the link between personality and behaviour (Stoinski *et al.*, 2004). Moreover, methodological studies, such as validating personality-trait ratings with behavioural observations, are often the focus of this work. The validity of one type of assessment versus another has been covered elsewhere, with trait ratings shown to be just as, if not more, reliable than behavioural observations (e.g. Vazire *et al.*, 2007); therefore, links between the two have been found and tend to be evident. For example, gorilla Dominance is related to received and given displacement (negative and positive, respectively) (Kuhar *et al.*, 2006; Schaefer & Steklis, 2014); and Extraversion/Agreeableness is related to affiliative, grooming, playing, approach and touching behaviours (Schaefer & Steklis, 2014). Similarly, Chimpanzee Extraversion is related to affiliative behaviour (Pederson *et al.*, 2005; Massen & Koski, 2014). A relationship has also been shown between Chimpanzee Dominance and agonistic behaviours (a positive relationship) and submissive behaviours (a negative relationship) (Freeman *et al.*, 2013). In the same study a relationship was also found between Extraversion and contact aggression. This type of research could have a direct impact on management decisions. For example, gorillas housed in solitary situations rated lower on the Understanding factor (Kuhar *et al.*, 2006). Although this result needs to

be validated, if it were the case, and Understanding was predictive of a need for solitary housing, planning for housing provision could be made easier, both within single zoos and across zoos. This could lead to a reduction of aggressive encounters, because gorillas rated lower for Understanding were also more likely to engage in non-contact aggression (Kuhar *et al.*, 2006). It has been suggested that gorilla groups should be formed when the apes are young for the best outcomes (Stoinski *et al.*, 2004), so it is vital to understand any age-related differences in personality, but this is not always possible in zoos (see Huskisson & Chism, 2018). Knowing that silverback gorillas rated highly on the personality dimension Understanding are more accepting of new members into their troop (Stoinski *et al.*, 2004) could be a vital piece of information that facilitates successful groupings. Longitudinal studies are particularly important for assessing any links between personality and age. For example, in Chimpanzees, Extraversion and Openness decline with age, while Agreeableness and Conscientiousness increase (King, J. E., *et al.*, 2008). In orangutans, Agreeableness declines with age, and while Extraversion also decreases as orangutans age, it does so differently from Chimpanzees (Weiss & King, 2015). Zoos are often in the position of having to move individuals within groups of animals, which can pose risks to both the individuals involved and their caretakers (Powell, 2010). Personality is another tool zoos can use to decrease risk and increase success when making decisions about forming new groups of great apes.

Personality can also affect other areas of animal management; for example, personality studies have shown that captive breeding can be facilitated in a number of ways. In felids, providing secluded enclosures and ample hiding spaces for animals that rate higher on tense or fearful personality factors can improve breeding success, as was found with Cheetahs *Acinonyx jubatus* (Wielebnowski, 1999). Similarly, making species-specific changes in enclosures and husbandry to align with personality differences has been shown to benefit breeding in Giant pandas *Ailuropoda melanoleuca* (Powell & Svoke, 2008). Using measurements such as faecal corticosteroids and behavioural observations can establish parameters for well-being that facilitate improved reproductive success, as has been found in Clouded leopards *Neofelis nebulosa* (Wielebnowski *et al.*, 2002).

Primate behaviour in zoos in response to exposure to humans, typically unknown visitors rather than familiar keepers, may also be impacted by personality. For example, solitary, irritable and aggressive Diana monkeys *Cercopithecus diana diana* demonstrate increased abnormal behaviour during peak visitor times, while active, playful and excitable individuals show species-typical behaviour, including play (Barlow *et al.*, 2007). For zoos, this information could be vital not only to animal welfare but also for visitor satisfaction, as visitors tend to prefer naturalistic exhibits that promote activity (Ryan & Saward, 2004; Fernandez *et al.*, 2009). Gorillas show more relaxed behaviours during low visitor density, and higher rates of aggression, autogrooming and stereotypies during high visitor density [Wells, 2005; see Ross *et al.* (2007) and Wells (2007) for discussion of these results]. Changes in group structure, such as the birth of an infant, may also have an effect on how gorillas react to visitors (e.g. Collins & Marples, 2016). Visitor density is not a stressor for all individuals (Hosey, 2000), and crowd size may or may not have an effect on behaviour in various species in zoos (Ross *et al.*, 2007; Bonnie *et al.*, 2016; Jones *et al.*, 2016; Martin, R. A., & Melfi, 2016; Polgár *et al.*, 2017). Using available knowledge about individual personality to schedule exposure to visitors could increase welfare and decrease unwanted behaviours in primates in zoos.

Environmental enrichment is a common tool that is used to increase both the physical and psychological well-being of animals in zoos; however, the efficacy of the enrichment provided may be affected by

personality (e.g. Massen *et al.*, 2013). A study of Snow leopards *Panthera uncia* suggested that personality may impact enrichment choices made by zoos (Gartner & Powell, 2012). Because enrichment has not been entirely successful in decreasing unwanted behaviours (Mason *et al.*, 2007), it would be useful to carry out more studies to assess the impact of enrichment and the different methodologies used for such studies. By understanding individual preferences that might have an impact on the effectiveness of enrichment, a more focused provision can be made to improve welfare, as well as possibly counteract unwanted behaviours (e.g. pacing). In addition, an individual's response to an enrichment item itself may be used as a metric for quantifying personality characteristics (Gartner & Powell, 2012; Massen *et al.*, 2013).

Enrichment can be used to challenge animals mentally and physically (Shepherdson, 1998), and can be conceived of on both the species and individual level (Mellen & Sevenich MacPhee, 2001). While little direct research has been carried out on personality and welfare, one study with Chimpanzees found that welfare measures correlate with subjective well-being measures, and that higher Extraversion and lower Neuroticism were related to higher ratings on the combined welfare/subjective well-being measure (Robinson *et al.*, 2017). Understanding an individual's personality can help keepers to create a proactive (rather than reactive) environment for zoo animals (Mellen & Sevenich MacPhee, 2001).

Great ape cognition and its relationship to personality is a growing field of study. Chimpanzees rated higher on Openness are more willing to participate in research studies (Herrelko *et al.*, 2012). Furthermore, those rated higher on Neuroticism performed more self-directed behaviours during the study (Herrelko *et al.*, 2012). This has implications for animal management, where animals rated higher on Openness could be chosen first for training, which may provide the more reluctant animals with positive role models.

While personality has the potential to predict behaviour, it is possibly also influenced by environment. Different types of rearing, including group size, group composition and experience of other infants within the group, may all have a different effect upon individuals. For instance, Chimpanzees that are reared in larger groups ($\geq$ 7 individuals) are rated more highly on positive personality traits (e.g. playful) than those reared in smaller groups ($\leq$ 3 individuals), but also are rated as more Irritable and Excitable/Slow (Murray, 1998). However, a later study by Martin, J. E. (2005) found no such associations, so more work on this subject is needed.

Finally, zoos are one of the largest supporters of conservation, both financially and with expertise (Barongi *et al.*, 2015). Personality can affect strategies for survival (Watters & Meehan, 2007), as well as reintroduction efforts (Bremner-Harrison *et al.*, 2004). Although relatively few zoo animals are reintroduced to the wild, some projects have been initiated and personality should be a consideration (e.g. Cocks & Bullo, 2008; King, T., & Courage, 2008). Some of these projects have brought back species from near extinction (e.g. Black-footed ferret *Mustela nigripes*, California condor *Gymnogyps californianus*, Golden lion tamarin *Leontopithecus rosalia*, the Karner Blue butterfly *Lycaeides melissa samuelis*, Oregon spotted frog *Rana pretiosa*, Palila *Loxioides bailleui*, Red wolf *Canis rufus* and Wyoming toad *Anaxyrus baxteri*) (see examples in Dobson & Lyles, 2000; Walters *et al.*, 2010). Studies carried out in zoos may inform work that is carried out in the wild and vice versa. For example, one study found a similar personality structure in zoo and sanctuary Chimpanzees (King, J. E., *et al.*, 2005), indicating that captivity may not affect the way that personality traits cluster together. In that study, the Chimpanzees at the sanctuary (wild born and rescued from a variety of non-normal situations) were being conditioned for reintroduction into the wild.

Studies carried out at zoos could inform managers of how animals should be

grouped for release, how they may react to release and in what stages release should occur. By using zoological records, such as information on pedigree, researchers can take this one step further to look at the genetics of natural selection and adaptation in captivity (Pelletier *et al.*, 2009). This could help zoos to limit contemporary evolution in captivity, which may affect future reintroductions to the wild, as well as such health outcomes as breeding success (Pelletier *et al.*, 2009).

The results of research into personality and behaviour of wild animals in zoos is promising, and should be encouraged. If personality allows for the prediction of behaviour, then zoo-animal management can be improved once such knowledge is available. The types of studies described above could be invaluable in animal management, as personality assessment would take some of the guesswork out of management decisions, which has the potential to increase psychological and physical welfare for animals in zoos.

These examples reveal some possibilities of the implications for animal management and, although zoos already play a role in learning about animal behaviour, there is still a wealth of work that could be done. For example, studies could be carried out in zoos to investigate how a better understanding of individual personality could make it possible to predict behaviour in primates. Research on human personality and behaviour is vast and varied, and can help zoos to begin to understand and predict how the animals in their care may react individually to different situations, as mentioned above. However, adaptations to study design are vital. Researchers focusing on humans often have access to larger sample sizes, allowing for generalizations about populations; however, researchers in zoos frequently do not have large numbers of animals to study. For example, for great apes in a single zoo there are usually only a small number of individuals and they are often housed together. This leads to numerous studies of single zoos, which are valuable but not definitive or generalizable, narrowing their usefulness. To counteract these limitations, many researchers recommend multi-zoo studies (Swaisgood & Shepherdson, 2005; Whitham & Wielebnowski, 2013). However, these too come with challenges. Including more than one zoo in a research project requires much time and effort to establish and maintain professional relationships, as well as ensuring the data collected from each institution is of the same quality and detail. Depending on the type of study, this could be relatively easy. For example, a pivotal study of personality and longevity in Western lowland gorillas included 43 zoos but the data came from one database, all of the zoos involved were from countries speaking the same language and one of the authors worked at one of the participating zoos (Weiss *et al.*, 2013). However, things become more difficult if data need to be collected by a researcher present at a zoo (e.g. behavioural data) or if the zoos involved are not all from countries speaking the same language (e.g. involving translations of test materials). Data collection from more than one zoo could then be hindered by monetary and time constraints, as well as lack of staff or a lack of interest. Anecdotally, experience demonstrates that personality studies still seem to face these problems in zoos, despite growing literature showing their importance. However, the Association of Zoos and Aquariums (AZA) has increased its focus on research, recently creating a Research and Technology Committee. AZA expects its members to conduct or facilitate research, and provides some grant funding for such projects. In addition, new technological projects, such as ZooMonitor, a Web application designed for easier and more reliable data collection, is available to zoos at little to no cost (https://zoomonitor.org: Lincoln Park Zoo, Chicago, IL, USA). This type of technology could facilitate multi-zoo studies with only minimal training required.

THE FUTURE OF ZOOS IN PERSONALITY RESEARCH

Research carried out at zoos has led to several advances in our understanding of personality, its antecedents, and its consequential effects in non-human primates, humans (e.g. the evolution of personality) and other animals. To continue this theme and foster high-quality research on other topics in primates and other species in zoos, we conclude by outlining some reasons why zoos are a good resource for research on personality and behavioural phenomena. Finally, some suggestions are offered to the wider community of zoos that will help make this research environment even better.

As mentioned earlier, one advantage of carrying out research in zoos is that by coordinating data collection across multiple zoos, it is possible to have large sample sizes, even of highly threatened species. For example, our study of Western lowland gorilla personality and longevity involved 283 gorillas at 42 zoos (Weiss *et al.*, 2013). These large sample sizes translate into greater statistical power and reproducible findings (Cohen, 1992). It may be possible to leverage the findings from genome-wide association studies, and launch the next generation of molecular genetic studies of primate personality.

Another advantage of studying animals in zoos is that these environments make it possible to achieve a balance of control and ecological validity (Petrinovich, 1979). Control is associated with experimental laboratory research, and refers to designs that make it possible to isolate stimuli (or combinations of stimuli) that cause an effect and to keep factors extraneous to the research question to a minimum (Kerlinger, 1964). The zoo setting provides control by complying with regulations for enclosure sizes, the provision of enrichment, diet and procedures that ensure the health of the animals, keeping the major aspects in the lives of animals constant. By mimicking the natural and social environments of the species in their care (e.g. forming social groups that resemble those of wild counterparts) zoos maintain some degree of ecological validity. In addition, zoo animals may be likely to demonstrate better examples of species behaviour (i.e. zoos encourage expressions of natural behaviour) than individuals housed in laboratories, where animals may be subject to conditions that do not encourage such behaviours (e.g. single housing of social species).

The study of personality and other behaviours in zoos also benefits from the fact that each enclosure and each zoo is a micro-environment. This variation can be harnessed in quasi-experimental studies (Cook & Campbell, 1979). For example, some studies have examined whether seeing and/or hearing visitors influences the behaviours of animals (i.e. a zoo effect) (Hosey, 2000), or how being closely related to other individuals in an enclosure influences behaviour (i.e. an enclosure effect) (Price & Stoinski, 2007). These effects are likely not independent, but analytic methods, such as mixed-effects modelling (Singer, 1998), can take this nesting of effects into account. These sorts of studies would be the flip side of field experiments, such as those described by Matsuzawa (2011).

Observations of animal personality and behaviour benefit from zoo-based studies because the staff at zoos are incredibly knowledgeable about the animals in their care. This has been borne out by studies that have evaluated the reliability of staff ratings of animal well-being, personality and welfare (e.g. Robinson *et al.*, 2017). The ratings zoo staff provide during such studies have led to real insights into personality evolution (e.g. King, J. E., & Weiss, 2011; Weiss, 2018). Detailed descriptions of animal behaviour can be found in the early ethological literature (e.g. Tinbergen, 1959). Researchers can utilize knowledge about common, rare or unusual behaviours, and the range of behaviours that staff have witnessed over long periods of time, providing a prime source for testable hypotheses. In addition, zoos house a diverse range of species, which means a large amount of research could be carried out to answer a variety of questions. While there may be some effects of contemporary evolution taking place, zoo animals

are specifically bred to conserve genetic diversity, a factor that allows for possible comparisons to wild counterparts, which may have an effect on future conservation efforts.

ENHANCING THE CONTRIBUTION OF ZOOS TO SCIENCE

Zoos are outstanding resources for personality research because they provide accessibility to multiple related species, which is crucial for comparative research. However, there are ways in which the scientific contributions of zoos can enhance the study of personality and other research areas. We invite readers to contact the authors if they have other suggestions or recommendations.

Standardized questionnaires

Using questionnaires to study personality (or behaviour) of zoo animals makes it possible to measure traits using a standardized format of data collection. This standardization is essential when collecting large amounts of information. The ChimpanZoo programme of the Jane Goodall Institute (http://www.chimpanzoo.org) showed considerable promise in this aspect of data collection. Chicago Zoological Society's Center for the Science of Animal Care and Welfare (Brookfield, IL, USA) has developed WelfareTrak®, a welfare-monitoring tool that utilizes the knowledge, skills and expertise of keepers (https://www.welfaretrak.org). At the time of writing, keeper ratings in WelfareTrak® are being validated against behavioural and hormonal data in Chimpanzees. These sorts of projects could also result in a standard core ethogram and a core set of behavioural tests for species that could be used in behavioural studies.

Data accessibility

A way to enhance personality and behaviour research would be to make basic demographic and relatedness data openly available. This would help researchers to choose appropriate individuals and facilities for focus and/or investigation of the genetic or environmental bases of behaviour. One good example of this is the Great Ape Information Network (GAIN: https://shigen.nig.ac.jp/gain). This freely accessible website offers detailed information about the Chimpanzees, orangutans, Gorillas, Bonobos and gibbons at Japanese zoos and research facilities, including personality profiles for the Chimpanzees. Although only accessible to members, the Zoo Information Management System (ZIMS) of Species360 (Bloomington, MN, USA) also provides a rich source of animal data.

Having one straightforward, unambiguous electronic system in place that allows for approval of proposed multi-zoo research from one source as well as feedback on rejections of project requests, would ease communication and other logistical problems that researchers face when trying to set up such studies.

CONCLUSION

As we have shown, zoos provide an invaluable resource for personality research. Local expertise and facilities may vary, and some zoos are better suited for learning studies and others for personality research. However, well-planned and relevant studies into personality, behaviour and cognition carried out in zoos can contribute to the literature and provide a solid basis for animal-management protocols. As available knowledge increases a corresponding improvement in the welfare, well-being and conservation of wild animals should also occur.

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