Full title: Furred and feathered friends: how attached are zoo keepers to the animals in their care?

Running title: Zoo keeper attachment to pets and zoo animals

Vicky Melfi[1†], Lindsay Skyner[2], Lynda Birke[3], Samantha J. Ward[4], Wendy S. Shaw[5], & Geoff Hosey[6]

[1] Animal and Agriculture Research Centre, Hartpury University, Gloucestershire

[2] Toi Ohomai Institute of Technology, Tauranga, Bay of Plenty, New Zealand

[3] Department of Biology, University of Chester, UK

[4] School of Animal, Rural & Environmental Sciences, Nottingham Trent University, UK

[5] PANGEA Centre, School of Biological, Earth & Environmental Sciences, University of New South Wales, Australia

[6] Biology, University of Bolton, UK

†Correspondence: vicky.melfi@hartpury.ac.uk

Abstract: Keeper-animal relationships (KARs) appear to be important in zoos, since they can enhance the well-being of both the animals and the keepers, can make animal husbandry easier, but conversely might risk inappropriate habituation of animals and possible risks to the safety of keepers. It is, therefore, important to know more about the variables involved in relationship formation. Here we use a modified version of the Lexington Attachment to Pets Scale (LAPS) to measure the strength of KARs between keepers and animals in their care, both in the zoo and in the home. LAPS questionnaires were completed by 187 keepers in 19 different collections across three countries. LAPS scores for attachment to zoo animals (ZA) were significantly lower than for pet animals (PA).

There was no significant difference in ZA scores between different taxa, but there were significant taxon differences between PA scores. There were significant differences in both ZA and PA scores between different collections. Female respondents scored more highly than males for both ZA and PA. Multiple regression revealed that location, gender and time spent with animals were significant predictors for ZA, while only gender and taxon were significant predictors for PA. It was concluded that PA scores were comparable with those for the general public, and reflected strong attachment of keepers to their pets, while ZA scores, although also reflecting attachment, were influenced by institutional culture differences and perhaps an acceptance of the ambiguities inherent in the relationship.

Keywords: keeper-animal relationships (KAR), Lexington Attachment to Pet Scale (LAPS), attachment, pet, zoo.

1. Introduction

Zoo staff in progressive accredited zoos attempt to ensure that the animals in their care experience the best possible welfare, not only because this is a laudable goal in its own right, but also because it is essential in achieving the zoos' educational and conservation mission and vision. Meehan et al., (2016) suggested that one of the strongest contributions to improving zoo animal welfare science is the investigation of the impact of human-animal interactions (HAIs). This view has developed, in part, because human-animal interactions studied in zoos (reviewed Ward and Melfi, 2013) have demonstrated a link between animal welfare and interactions with keepers. Encouraging positive keeper-animal relationships (KARs), which result from positive human-animal interactions, can facilitate the development of positive affective states in the animals (Wielebnowski et al., 2002).

Animals in zoos are capable of discriminating between and responding differentially to unfamiliar and familiar keepers (Martin and Melfi, 2016) and also between different familiar keepers (Ward and Melfi, 2015). Furthermore, animals who had undergone positive reinforcement training (PRT) showed faster response times to keeper cues, suggesting that PRT can help strengthen the animals KARs (Ward and Melfi, 2013). For instance, when keepers spent more time with gorillas in training and play sessions, they showed reduced stereotypies, inactivity and aggression (Carrasco et al., 2009). There can be longer term effects as well. Increased time spent with familiar keepers appears to be associated with more successful reproduction in small felids (Mellen, 1991; Wielebnowski et al., 2002). None of this is particularly surprising, as there is ample evidence from other contexts of the benefits to animal welfare of good human-animal relationships (HARs) between caretakers or stockpersons and the animals in their care (Hosey and Melfi, 2019a). This evidence comes from studies with agricultural animals (Boivin et al., 2003; Hemsworth, 2003; Waiblinger, 2019), companion animals (Serpell, 2019) and animals in laboratories (Coleman and Heagarty, 2019).

Keepers also benefit from relationships with animals in their care. At an operational level, keepers report that good relationships with the animals they care for allow them to manage the animals more easily, because the animals respond more quickly to cues, and because the knowledge keepers have of individual animals permits them to better monitor health and welfare of those animals (Hosey and Melfi, 2012). At a more affective level these relationships bring about feelings of well-being and job satisfaction in keepers (Hosey and Melfi, 2012), which mirrors comparable results for caretakers of animals in laboratories (Coleman and Heagerty, 2019; Chang and Hart, 2002) and stockpersons working with agricultural animals (Waiblinger, 2019). Again, this is not particularly surprising as most of us are subjectively aware of the emotional benefits of companion animals. The association between HARs and positive affective states in humans, particularly with dogs, has been well researched for several decades and has shown that as well as general feelings of well-being in pet owners there are additional and often specific health benefits (Friedman et al., 1980; Friedman et al., 1983; Beetz et al., 2012; Virués-Ortega and Buela-Casal, 2006). Thus, good HARs can potentially benefit humans as well as animals.

Differences arise between the HARs of zookeepers and animals in their care, and pet owners and their pets (Melfi and Hosey, 2019a). The intimacy and duration of contact between zookeepers and the animal in their care are generally less than those experienced by pet owners and their pet. Furthermore, zoo animals are not domesticated and are therefore less likely to be amenable to human contact. The HARs that pet owners have with their pets are often referred to as bonds (human-animal bonds, or HABs). These can be thought of as high quality HARs which occur dyadically and reciprocally (i.e. they occur between just two interactants, both of whom contribute positively to the relationship), and which confer feelings of well-being in both parties (Hosey and Melfi, 2019a; Russow, 2002). While these characteristics are likely to occur with domesticated dogs (Konok et al., 2011; Prato-Previde et al., 2003; Mariti et al., 2013a), HABs have rarely been studied, or demonstrated with other animals, and certainly not with zoo animals. This raises questions about whether the KARs in zoos are equivalent to the HARs in other human-animal contexts, in particular increments to welfare and well-being for both animals and keepers. Though studies of KARs suggest the possibility of enhanced animal welfare, this has not yet been empirically studied (Patel et al., 2019) and the relationship is clearly complex. After interactions with keepers, gorillas and chimpanzees in one study showed lower rates of self-directed behaviors, but higher rates of agonism (Chelluri et al., 2013), and in another study, sheep and goats in a contact yard responded more negatively to the public when keepers were close than when they were distant (Anderson et al., 2004). These data suggest that there may be costs as well as benefits associated with HAIs. One cost illustrated by these studies is that new undesirable behaviors may be introduced into the animals' repertoire or their performance maybe exaggerated through KAI. Such undesirable behaviors appear to be learned and might include excessive habituation, inappropriate behaviors towards humans, including zoo visitors (e.g. begging, soliciting interaction, aggression), and reduction of species-typical behaviors. While these are not necessarily unwanted (e.g. habituation might be desirable in animals used in educational events), they may nevertheless constitute a potential cost to the animal in other circumstances.

More worryingly, animal attacks on keepers, while rare, have occurred. These have happened where staff appear to have good KARs with the animals in their care (Hosey and Melfi, 2015). The implication is that the animal and keeper may perceive the KAR quite differently. Probing the animal's point of view is methodologically difficult and has not been attempted with zoo animals due to the lack of a standardized method (Patel et al., 2019) but is perhaps feasible using some of the tests for companion animal attachment (Melfi and Hosey, 2019b) in a suitably modified way. This is a challenge for future research. Meanwhile, this study probes the keeper's perspective on the KARs with their animals. In interview, keepers are generally aware of the contradictory nature of their relationships with zoo animals (Birke et al., 2019). Here, we attempt to quantify keeper perceptions of the KAR using a psychometric test, the Lexington Attachment to Pets Scale (LAPS), suitably modified for use in a zoo context, and test the Null Hypothesis that keepers' attachment to a zoo animal that they believe they have a bond with, is not different in strength from their attachment to a companion animal. In an initial test with this instrument (Hosey et al., 2018) we were able to reject the Null Hypothesis, as the keepers' attachment scores were significantly lower for their zoo animals than for their companion animals. In that trial, however, we had a sample of just 22 keepers from two zoos. Here we apply the test to a larger sample of keepers from a greater array of zoos, which offers the possibility of identifying whether the bonded animal species, the location, or the zoo, have an influence on the strength of the reported KAR.

2. Materials and Methods

We used a modified version of the Lexington Attachment to Pets Scale (LAPS) questionnaire (zoo LAPS, see appendix), which in its original form (pet LAPS) is used to measure the strength of attachment of pet owners to their animals (Johnson et al., 1992). In the zoo LAPS version, words which are used to denote companion animals have been replaced with words which signify animals generically, so that the questionnaire is rendered suitable for use in a zoo context. The zoo LAPS was previously trialed in a small (n=22 respondents) sample of keepers (see [Hosey et al., 2018] for full details of the questionnaire). Each respondent was asked to complete the zoo LAPS for an animal in the zoo with whom they believed they had a bond, and to complete the pet LAPS for any companion animal they owned. We asked respondents for the following demographic information: their gender and age group (<20, 20-40, >40), how many years they had worked as a keeper, how many years they had worked with or owned the animals they identified as having bonds with, and whether or not they thought it was appropriate for zoo keepers to develop bonds with their animals. We asked for the species of animal in each of their questionnaires. Respondents were first asked if they felt that they had a bond (defined in the questionnaire) with an animal in their care. If they ticked 'yes' they went on to complete the zoo LAPS. Respondents who did not have pets only completed the zoo LAPS.

There are 23 statements in the LAPS questionnaire. Using a Likert Scale, respondents were asked to mark one of four possible responses to indicate the level of their agreement with each statement:

strongly agree, somewhat agree, somewhat disagree or strongly disagree. Two of the statements gave a negative viewpoint and were therefore scored in the opposite direction from the others as a check on consistency of responding. The statements tested three different aspects of attachment: general attachment, people substituting (i.e. using bonds with animals as a substitute for bonds with humans) and animal rights/welfare. We randomized the order of the 23 questions for the zoo LAPS, and then inverted that order for the pet LAPS to minimize order effects.

The questionnaires were distributed to 19 different zoos, of which six were in the UK, one in Australia, and 12 in New Zealand. Zoos ranged from large zoos with several thousand animals and annual attendances of a million or more visitors to small collections with hundreds of animals. In each zoo, keepers were asked to fill in the questionnaires individually, so as not to be influenced by others. Completion of questionnaires was voluntary, and responses were anonymized. The project was given ethical approval by the University of New South Wales Human Research Ethics Advisory Panel (Psychology, File number 2132, 2013), and by the Ethics board of one of the participating zoos (Chester).

Data Analysis

Questionnaires were scored where ‘strongly agree’ was scored 3, ‘somewhat agree’ 2, ‘somewhat disagree’ 1, and ‘strongly disagree’ 0, with the two negative statements coded in reverse. From this, total scores could be obtained for each respondent for the questionnaire as a whole, and for each of the three attachment subcategories. Thus, for each respondent we could obtain zoo attachment scores (ZA) and pet attachment scores (PA). Scores were not normally distributed, so non-parametric tests were used to analyze the results. Related samples Friedman’s 2-way analysis of variance was used to compare ZA and PA scores, Independent samples Kruskal Wallis tests were used to compare scores between our other independent variables. Relationships between scores and the time respondents had spent with their animals were investigated using Pearson correlation coefficients. Finally, simple multiple regression analyses were carried out with ZA and PA scores as dependent variables and taxon, view of bonds (i.e. whether or not keepers deemed bonds with zoo animals as appropriate), years with animal, years as keeper, location, gender and age group as possible predictor variables. All analyses were carried out with SPSS version 20.

3. Results

3.1. Respondents

A total of 187 completed questionnaires (70♂, 117♀) were generated in 19 different zoo collections. Within the total of 187 completed questionnaires, 139 respondents (51♂, 88♀) completed the zoo LAPS questionnaire, and 144 (48♂, 96♀) completed the pet LAPS questionnaire. More than half of respondents (n=108) filled in both the zoo LAPS and the pet LAPS. Most respondents (n=142) were in the age range 20-40yrs, with 2 <20yrs and 43 >40yrs. Most respondents (n=166) thought it was appropriate for zookeepers to have bonds with zoo animals, while 17 thought it was not appropriate, and four did not answer this question.

3.2. Comparisons

Comparison of total ZA with total PA scores revealed that PA scores were significantly higher than ZA scores (ZA, mean±SE = 41.91±0.97; PA = 50.87±0.898; Friedman test $\chi2=7.64$, $n=108$, $p<0.001$). Because only 58% of respondents filled in both the zoo LAPS and the pet LAPS, we also compared these using the Mann-Whitney test, as if our two questionnaires were independent samples, and got the same result ($U=14.312$, $n=284$, $p<0.001$), confirming that those who filled in both questionnaires were not an unusual subset of our sample. We then compared ZA and PA scores for each of the sub-categories of response (i.e. general attachment, people substitute and animal rights/welfare); in each case PA scores were significantly higher than ZA scores (general attachment, ZA mean±SE = 22.09±0.47, PA = 27.14±0.38, Friedman test $\chi2=7.58$, $p<0.001$; people substitute, ZA = 9.18±0.37, PA = 11.46±0.41, χ2=6.56, p<0.001; animal rights/welfare, ZA = 10.37±0.23, PA = 12.3±0.2, χ2=7.33, p<0.001).

Female respondents had significantly higher ZA scores (mean±SE, ♀=43.43±1.12, ♂=39.29±1.75; U=2713.5, n=139, p=0.04) and PA scores (♀=53.1±0.94, ♂=46.4±1.77; U=3026.5, n=144, p=0.002) than males. There was no significant difference in either ZA or PA scores across the three age groups (Kruskal Wallis test, ZA: χ2=1.04, 2df, n=139, p=0.595, ns; PA: χ2=2.21, 2df, n=144, p=0.546, ns). The number of years of experience respondents had as keepers was not correlated with their ZA score (r= -0.148, ns), nor was the number of years they had spent with the animal they had a bond with (r= 0.049, ns). Similarly, their number of years with their companion animal was not correlated with their PA score (r=0.025, ns). Finally, there was no significant difference in either ZA or PA scores between those who did and those who did not think it was appropriate for keepers to have a bond with a zoo animal (Kruskal Wallis test, ZA: χ2=5.86, n=139, 2df, p=0.054, ns; PA: χ2=4.98, n=144, 2df, p=0.083, ns; 2df because there was an additional category "no answer").

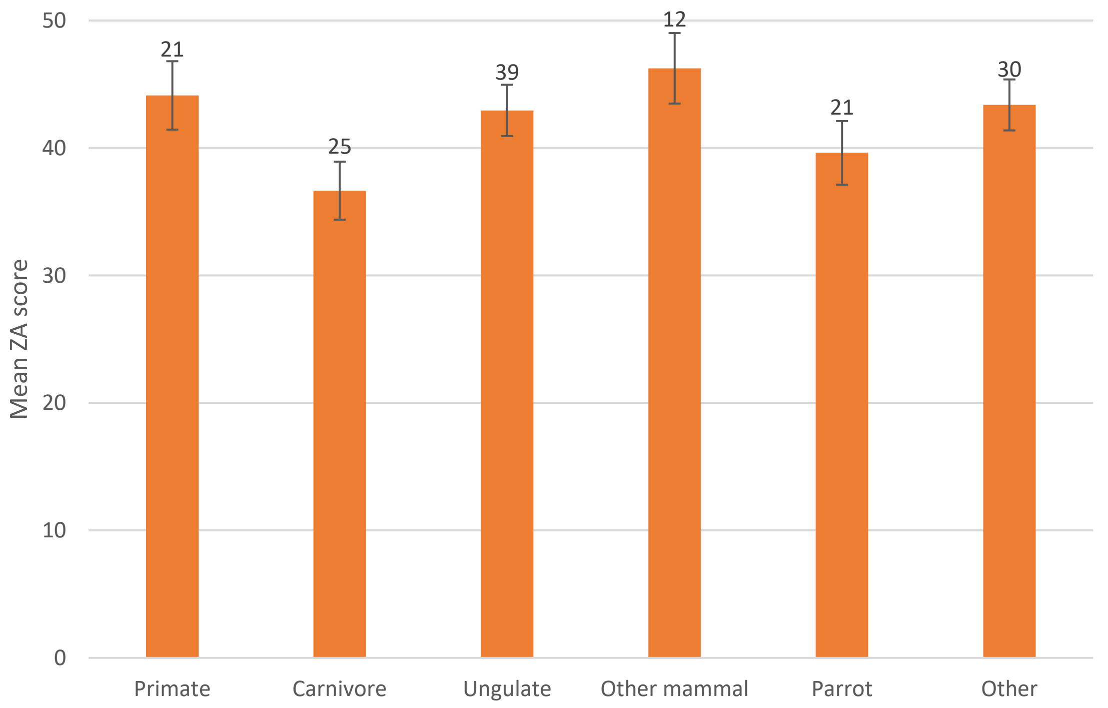

Figure 1. Mean ZA scores for the different taxon groups in which respondents reported a bond.

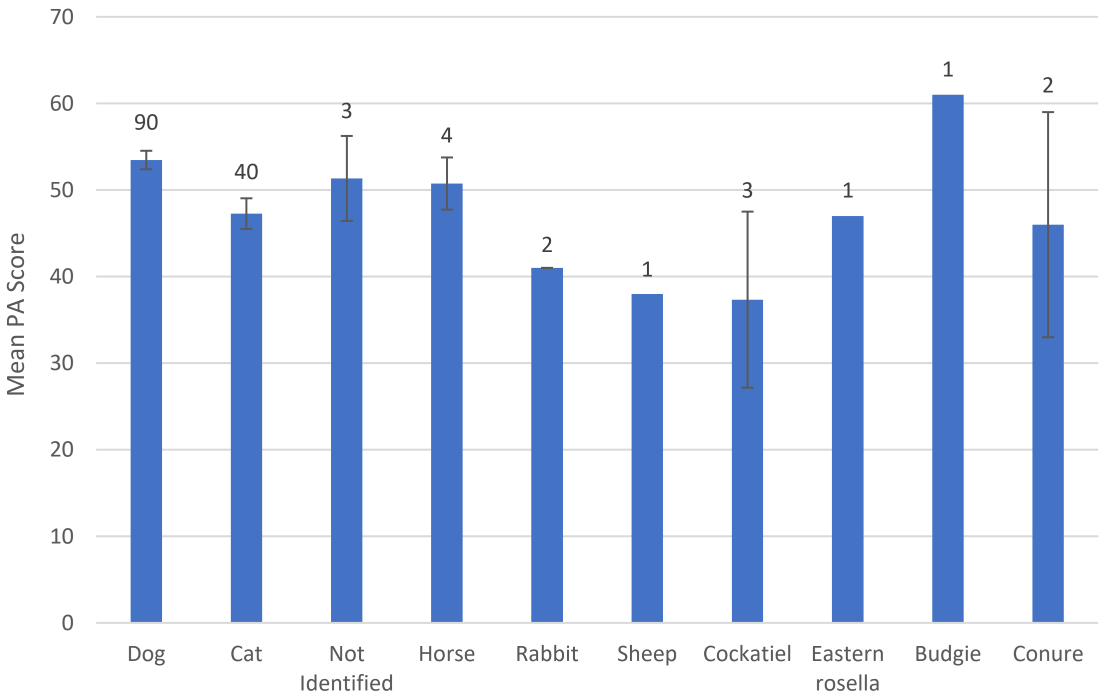

Figure 2. Mean PA scores for the different pet animal taxa with which respondents reported having a bond.

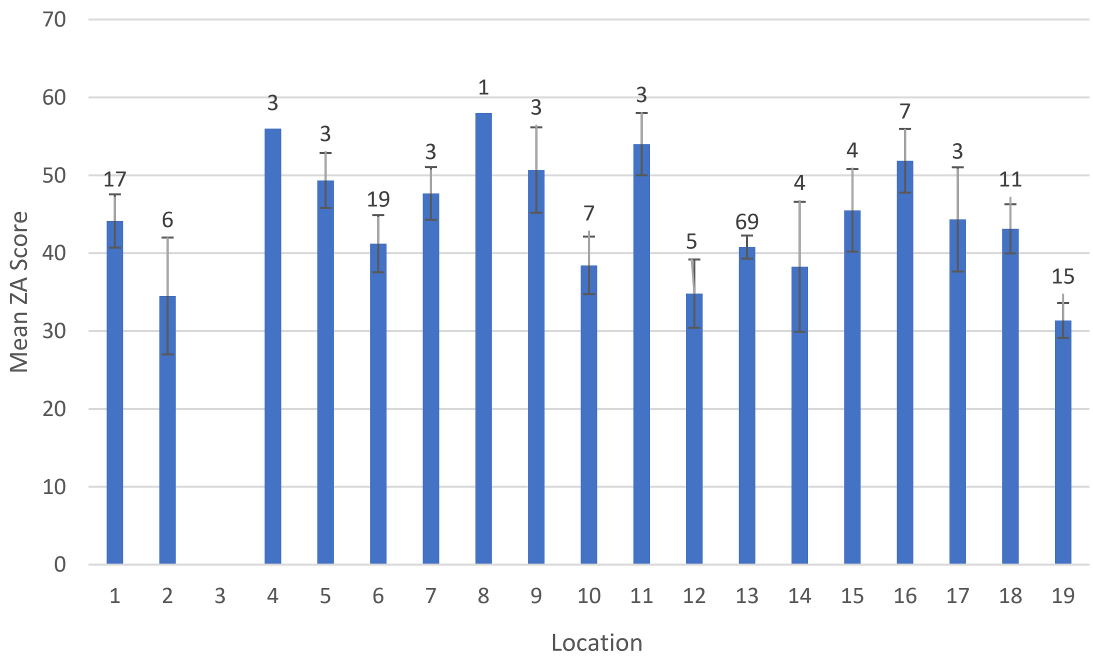

Figure 3. Mean ZA scores for the different zoos in the survey.

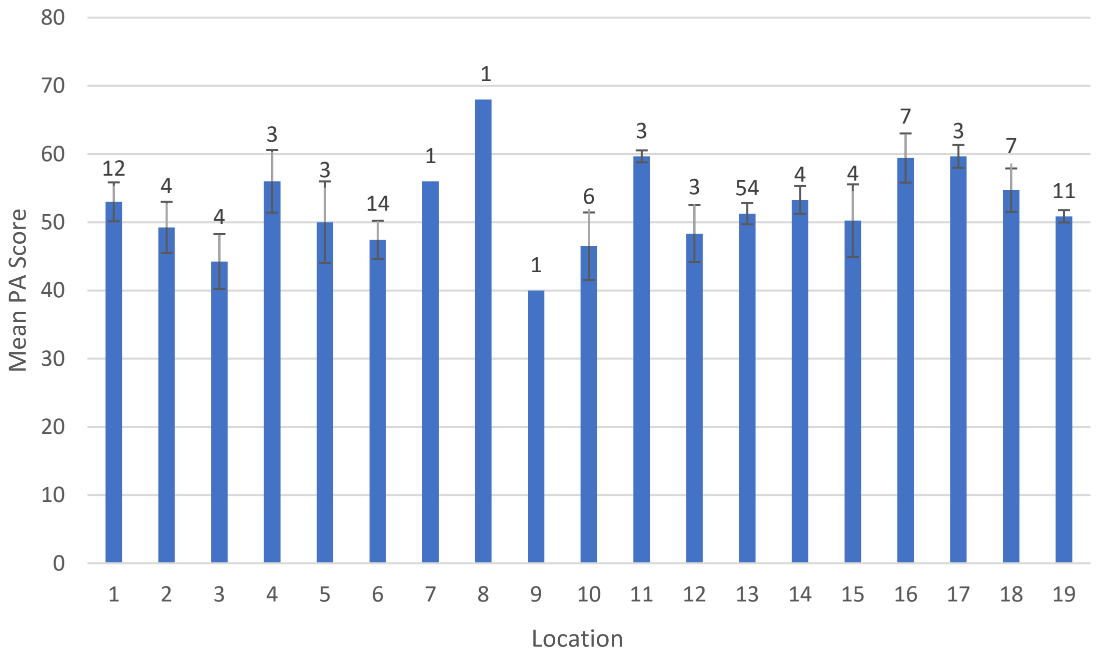

Figure 4. Mean PA scores reported by respondents for the different zoos in the survey.

Respondents reported bonds with 72 different taxa of zoo animals, which for analysis we collapsed down into six categories (Figure 1): primate (n=16), carnivore (n=23), ungulate (n=38), other mammal (n=12), parrot (n=21) and other (n=29). There was no significant difference between ZA scores for different taxa (Kruskal Wallis test: $\chi2=8.7$, 5df, n=139, p=0.122, ns). There were nine taxon categories of pet animals reported, however some respondents failed to disclose the species of their pet. There were significant differences between PA scores for these different categories (Kruskal Wallis test: $\chi2=17.95$, 9df, n=143, p=0.036;Figure 2). Keepers from 19 different collections completed the questionnaires. There were significant differences in both ZA (Kruskal Wallis test, $\chi2=30.98$, 17df, n=139, p=0.02) and PA scores ($\chi2=29.88$, 18df, n=144, p=0.039) across different zoos (Figures 3 and 4). The ZA and PA scores of the different zoos were significantly correlated (r=0.569, $p<0.05$), such that those zoos where there were high ZA scores also showed high PA scores.

3.3. Multiple Regression

Multiple regression of ZA scores for the whole sample gave a significant model ($F_{7, 112}=3.29$, $p<0.005$, $R^2=0.17$) which accounted for 17% of the variance in the scores. Location, gender of respondent and number of years the respondent had spent with the animal were significant predictors, but none of the other variables was significant (Table 1). Multiple regression of PA scores also gave a significant model ($F_{5, 136}=4.67$, $p=0.001$, $R^2=0.15$), which accounted for 15% of the variance in the scores. Only gender of respondent and taxon of pet were significant predictors (Table 1).

Table 1. about here

4. Discussion

The ZA scores for respondents in this sample were significantly lower than their PA scores. This indicates that the keepers had stronger attachments to their companion animals than they did to the animals they cared for, and claimed to have bonds with, in zoos. This is consistent with the results of a trial run with this zoo LAPS with a much smaller sample of keepers (Hosey et al., 2018), where again PA scores were higher than ZA scores. The ZA scores in the previous study (32.89±2.6) were lower than the average scores presented for this study but were within the range reported here (Figure 4), though clearly towards the bottom end of that range. The PA scores in our sample are comparable with those of pet owners reported in the literature. In their original LAPS paper (Johnson et al., 1992) reported scores of 49.2 for dog owners and 45.1 for cat owners. In other studies, mean pet attachment LAPS scores have been reported of 55 for residents of a nursing home towards animal-assisted therapy (AAT) dogs (Banks et al., 2007), 56.5 for dog walkers (Stephens et al., 2012), and 55.4 for dog owners (Mariti at el., 2013b). These figures are comparable with the mean PA score of our respondents (50.87), suggesting that zoo keepers do not differ from the rest of the population in the strength of their attachment to their pets.

LAPS scores are conventionally categorized as low (0-22), medium (23-46) or high (47-69) in strength (Marinelli et al., 2007), so the ZA scores of our respondents (41.91), while weaker than their PA scores, are nevertheless of medium strength. There is little in the literature to compare these scores with. Cat owners had lower average scores than dog owners (Johnson et al., 1992), but these are still pet animals. Even robotic dogs generated LAPS scores of 47.2 in nursing home residents (Banks et al., 2007). Why ZA scores should be lower than PA scores in the same respondents is unclear. A likely explanation is that the relationships keepers have with their zoo animals are much less intimate than those that they and other people have with their companion animals. People spend much more time with their pets, including relaxing with them, exercising with them, and sometimes treating them as ‘members of the family’, none of which is possible with zoo animals. Zoo keepers are aware of the ambiguous nature of their relationships with zoo animals (Birke et al., 2019), not only in terms of the lack of opportunity for close contact, but also because of the inherent contradictions and risks of treating wild animals as if they were not wild. It is, of course, possible that this awareness results in keepers under-reporting the strength of their attachments to zoo animals, although this seems unlikely in the light of the strongly emotional statements they make about what they see as bonds with their animals (Hosey and Melfi, 2012). Keepers might also actively work to ‘downplay’ these bonds so that they can gain a greater sense of objectivity when considering the animals they work with; this could arise from a work or societal culture which promotes an ethos where distancing between animals and people is positively regarded. Though few empirical studies have explored this area, the impact of naming animals in different contexts (including farms and laboratories) has been demonstrated to change the way humans perceive and treat animals (reviewed Erard, 2017). As a result many organizations are averse to naming animals. For example, that a giraffe was named was attributed internally at Copenhagen Zoo for the sensationalized media storm that followed its death (personal observation, Vicky Melfi). The negative ramifications of this were largely reported outside of

Denmark (Zimmerman et al., 2014). This incident exemplifies how cultural differences and contradictory expectations of zoos can influence perceptions of HAI (Cohen and Fennell, 2016), from which keepers are likely not exempt (Birke et al., 2019). It is, however, worth noting that both the ZA and PA scores of the keepers in the subcategory “people substituting” were particularly low (9.18 and 11.46 respectively) compared to, for example, nursing home residents reporting about AAT dogs (16.5) and even robotic dogs (13.4; [Banks et al., 2007], implying that zookeepers might view both their zoo and companion animals in a qualitatively different way from ordinary members of the population.

Both the ZA and PA LAPS scores in our sample of keepers were higher in female than male respondents. A similar gender difference for PA scores was found by Johnson et al. (1992), who reported male average scores of 45.1, compared with 50 for females. Other studies, however, have found no gender difference (Bagley and Gonsman, 2005), or have detected slightly higher LAPS PA scores in men than women (39 compared with 37.2 [Miller et al., 2009]; although in this study there was no statistical comparison between these results, so it is difficult to know how to interpret them. In a study with children, Daly and Morton (2003) found no gender differences in attachment to dogs, though there were differences in attachment to cats. Reviewing these studies, along with others using methodologies other than LAPS, such as telephone interviews, Herzog (2007) concluded that gender differences in attachment to pets are typically small, and there were considerable overlaps in the distribution of male and female scores. Intriguingly, oxytocin levels increased in female subjects after interaction with a bonded dog but decreased in males (Miller et al., 2009). Furthermore, in children high PA scores are related to high empathy, and girls are reported to be significantly more empathic than boys (Daly and Morton, 2006). How all of this relates to our results is unclear: they may show an underlying gender difference in the willingness of keepers to form bonds with their animals, or it may instead reflect greater willingness on the part of female keepers to report strong attachments.

There are few indications in the literature as to whether there are differences in LAPS PA scores in the general population for different kinds of companion animal. Scores for dog ownership have been reported to be higher than for cat ownership (Banks et al., 2007), but other studies which investigate both dog and cat ownership either do not compare the two, or else fail to report the descriptive data (i.e. the LAPS scores). In our sample of keepers there were significant differences in PA scores for differing species of pets (Figure 2), but surprisingly, no significant difference in ZA scores for different taxa of bonded zoo animals (Figure 1). This is surprising given the sheer diversity of species that keepers report themselves as having bonds with. Among our respondents there were reports of bonds with 72 different species, ranging from red river hog *Potamochoerus porcus* and quokka *Setonix brachyurus* to tiger *Panthera tigris* and chimpanzee *Pan troglodytes* among mammals; kea *Nestor notabilis* to brown teal *Anas chlorotis* among birds; and reptiles (giant tortoise, Testudinidae). There are no data in the literature with which to compare these results, although more generally the wide range of taxa that keepers report bonds with has been noted before (Hosey and Melfi, 2012). Why there is no difference in ZA scores for different taxa, and why taxon does not predict the strength of ZA scores in multiple regression is unclear. Models of HARs in a zoo setting predict that there will be species differences in the way animals respond to humans interacting with them, largely because species with different ecology and social behavior are likely to perceive humans in different ways (Hosey, 2008; Hosey, 2013). There is some empirical support for this prediction (Ward and Melfi, 2013; Carlstead, 2009; Serpell, 1996). If there really are such species differences, then the implication is that the perception by keepers of the bonds they have with their animals is not totally determined by the way the animals respond to them, but may include components which reflect other aspects of their job, such as professional responsibility or institutional culture. This might also help explain why ZA scores are on average lower than PA scores, since presumably keeper relationships with their pet animals are related to the way their animals respond to them, as appears to be the case with the population at large (Serpell, 1996).

Finally, there are differences in LAPS ZA scores in our sample across the different institutions that took part in the survey (Figure 3), and location was a significant predictor of ZA strength. This is partly explicable by the different husbandry protocols of the zoos in our sample. For example collection number 3, with the lowest mean ZA score, only houses kiwi, which do not readily imprint on people after hatching, and collections number 2 and 12 house primarily New Zealand native birds, many of which are destined for release, so interaction with humans is minimized. At collection number 7, by contrast, staff work closely with birds of prey in preparation for educational shows, so the opportunities for KAR development are presumably higher; but the reported ZA scores are lower. It is, however, likely that in addition, different institutional cultures develop in which the formation of KARs may be encouraged or discouraged to different extents within different zoos, different laboratories using animals may similarly develop different local cultures, which impact how animals are handled, and how regulations are interpreted (Arluke and Sanders, 1996; Davies et al., 2018). Regardless of institutional culture, keepers have their own individual views of how appropriate it is to form a KAR with an animal, but this doesn't appear to affect the strength of their ZA score.

Zoos differ from one another on many levels. A large number of multi-zoo studies have previously set out specifically to qualify and quantify the physical and operational differences between zoos, the majority of which consider how these might impact animal behavior and welfare [e.g. Carlstead et al., 1999; Greco et al., 2017)]. The importance of the animals' housing and husbandry conditions on their behavior and welfare is thus well recognized (Hosey et al., 2013). The current study extends upon this foundation, providing empirical data which alludes to cultural differences between zoos which influence keepers, with respect to KAR, as evidenced through self-reports on the strength of their relationship with the animals in their care. Different zoo cultures might influence the keepers' knowledge, attitude and empathy towards the animals in their care and thus as a group, keepers in one zoo would be expected to be more similar to one another, than keepers in other zoos: knowledge, attitude and empathy for animals have been found to be instrumental in the development of human-animal relationships in other contexts (Hosey and Melfi, 2019b; Hemsworth and Coleman, 2010).

Alternatively, zoo culture might act as a societal pressure, influencing the keepers self-reports of their KAR, to ensure they sit within a predetermined benchmark which reflects the views of their institution (however these might be generated or promulgated). What is new and exciting about this study, is the appreciation, supported by empirical data, that differences between zoos influence KAR. The next step is to disentangle whether different zoo cultures generate likeminded keepers, forming relatively uniform KAR with the animals in their care, or act as a social normalizer, influencing how keepers report on their KAR so they 'tow the zoo line'.

Acknowledgments: We are grateful to all the keepers who made the time and effort to fill in our questionnaires, and to the different zoos that permitted us to work with them: International Antarctic Centre, Blacon City Farm, Butterfly Creek, Chester Zoo, Gibbs Farm, Hamilton Zoo, Hoo Farm, The National Kiwi Hatchery formerly known as the Kiwi Encounter, Orana Wildlife Park, Ōtorohanga Kiwi House, The Isaac Conservation and Wildlife Trust, Rainbow Springs Nature Park, South Lakes Wild Animal Park, Taronga Zoo, Te Puia, Ty Mawr Animal Farm, Welsh Mountain Zoo, Willowbank Wildlife Reserve and Wingspan National Bird of Prey Centre. Thanks to Tamsin Young at Glyndwr University for helping with data collection from Welsh Mountain, Hoo farm and Ty Mawr. Further thanks to Jessica Meade for coordinating data collection at Taronga Zoo.

References

Arluke, A. & Sanders, C. (1996). Regarding Animals. Philadelphia: Temple University Press.

Anderson, U.S., Maple, T.L. & Bloomsmith, M.A. (2004). A close keeper-nonhuman animal distance does not reduce undesirable behavior in contact yard goats and sheep. Journal of Applied Animal Welfare Science, 7, 59-69.

Bagley, D.K. & Gonsman, V.L. (2005). Pet attachment and personality type. Anthrozoös, 18: 28-42

Banks, M.R., Willoughby, L.M. & Banks, W.A. (2007). Animal-assisted therapy and loneliness in nursing homes: use of robotic versus living dogs. Journal of the American Medical Directors Association, 9, 173-177.

Beetz, A., Uvnäs-Moberg, K., Julius, H. & Kotrschal, K. (2012). Psychosocial and psychophysiological effects of human-animal interactions: the possible role of oxytocin. Frontiers in Psychology, 3, 234, 1-15.

Birke, L., Melfi, V. & Hosey, G. (2019). ‘You can’t really hug a tiger’: zookeepers and their bonds with animals. Anthrozoös, 32(4), 597-.612.

Boivin, X., Lensink, J., Tallet, C. & Veissier, I. (2003). Stockmanship and farm animal welfare. Animal Welfare, 12, 479–492.

Carlstead, K. A (2009). Comparative Approach to the Study of Keeper–Animal Relationships in the Zoo. Zoo Biology, 28, 589–608.

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

Carrasco, L., Colell, M., Calvo, M., Abelló, M.T., Velasco, M. & Posada, S. (2009). Benefits of training/playing therapy in a group of captive lowland gorillas (Gorilla gorilla gorilla). Animal Welfare, 18, 9-19.

Chang, F.T. & Hart, L.A. (2002). Human-animal bonds in the laboratory: how the animal behaviour affects the perspectives of caregivers. ILAR Journal, 43, 10-18.

Chelluri, G.I., Ross, S.R. & Wagner, K.E. (2013). Behavioral correlates and welfare implications of informal interactions between caretakers and zoo-housed chimpanzees and gorillas. Applied Animal Behaviour Science, 147, 306-315.

Cohen, E. & Fennell, D. (2016). The elimination of Marius, the giraffe: humanitarian act or callous management decision? Tourism Recreation Research, 41(2), 168-176.

Coleman, K. & Heagerty, A. (2019). Human-animal interactions in the research environment. In: Hosey, G., Melfi, V. (Eds.), Anthrozoology; Human-Animal Interactions in Wild and Domesticated Animals. Oxford University Press, Oxford, UK, 2019; pp 59-80.

Daly, B., & Morton, L.L. (2003). Children with pets do not show higher empathy: a challenge to current views. Anthrozoös, 16, 298-314.

Daly, B. & Morton, L.L. (2006). An investigation of human-animal interactions and empathy as related to pet preference, ownership, attachment, and attitudes in children. Anthrozoös, 19, 113-127.

Davies, G., Greenhough, B., Hobson-West, P. & Kirk, R.G.W. (2018). Science, Culture and Care in Laboratory Animal Research: interdisciplinary perspectives on the history and future of the 3Rs. Science, Technology and Human Values, 43(4), 603-621

Erard, M. (2017). What's in a name? Science, 347(6225), 941-943.

Friedmann, E., Katcher, A.H., Lynch, J.J. & Thomas, S.A. (1980). Animal companions and one –year survival of patients after discharge from a coronary care unit. Public Health Reports, 95, 307-312.

Friedmann, E., Katcher, A.H., Thomas, S.A., Lynch, J.J. & Messent, P.R. (1983). Social interaction and blood pressure: influence of animal companions. Journal of Nervous and Mental Disease, 171, 461-465.

Greco, B. J., Meehan, C. L. & Heinsius, J. L., (2017). Mench, J. A. Why pace? The influence of social, housing, management, life history, and demographic characteristics on locomotor stereotypy in zoo elephants. Applied Animal Behaviour Science, 194, 104-111.

Hemsworth, P. H. (2003). Human–animal interactions in livestock production. Applied Animal Behaviour Science, 81, 185–198.

Hemsworth, P. H. & Coleman, G. J. (2010). Human-livestock interactions: The stockperson and the productivity of intensively farmed animals. CABI.

Herzog, H.A. (2007). Gender differences in human-animal interactions: a review. Anthrozoös, 20, 7-21.

Hosey, G. (2008). A preliminary model of human-animal relationships in the zoo. Applied Animal Behaviour Science, 109, 105-127.

Hosey, G. (2013). Hediger revisited: how do zoo animals see us? Journal of Applied Animal Welfare Science, 16 (4). doi.org/10.1080/10888705.2013.827916.

Hosey, G., Birke, L., Shaw, W.S. & Melfi, V. (2018). Measuring the strength of human-animal bonds in zoos. Anthrozoös, 2018, 31, 273-281.

Hosey, G. & Melfi, V. (2012). Human-animal bonds between zoo professionals and the animals in their care. Zoo Biology, 31, 13-26.

Hosey, G. & Melfi, V. (2015). Are we ignoring neutral and negative human-animal relationships in zoos? Zoo Biology, 34, 1-8.

Hosey, G. & Melfi, V. (2019a). Introduction. In: Hosey, G., Melfi, V. (Eds), Anthrozoology; Human-Animal Interactions in Wild and Domesticated Animals. Oxford University Press, Oxford, UK. pp 1-16.

Hosey, G. & Melfi, V. (2019b) Anthrozoology; Human-Animal Interactions in Wild and Domesticated Animals. Oxford University Press, Oxford, UK..

Hosey, G., Melfi, V. & Pankhurst, S. (2013). Zoo animals: behaviour, management, and welfare. Oxford University Press.

Johnson, T.P., Garrity, T.F. & Stallones, L. (1992). Psychometric evaluation of the Lexington Attachment to Pets Scale (Laps). Anthrozoös, 5, 160-175.

Konok, V., Dóka, A. & Miklósi, A. (2011). The behaviour of the domestic dog (Canis familiaris) during separation from and reunion with the owner: a questionnaire and an experimental study. Applied Animal Behaviour Science, 135, 300-308.

Mariti, C., Ricci, E., Zilocchi, M. & Gazzano, A. (2013a). Owners as a secure base for their dogs. Behaviour, 150, 1275-1294.

Mariti, C., Ricci, E., Carlone, B., Moore, J.L., Sighieri, C. & Gazzano, (2013b). A. Dog attachment to man: a comparison between pet and working dogs. Journal of Veterinary Behaviour, 8, 135-145.

Marinelli, L., Adamelli, S., Normando, S. & Bono, G. (2007).Quality of life of the pet dog: influence of owner and dog's characteristics. Applied Animal Behaviour Science, 108, 143-156.

Martin, R.A. & Melfi, V. A. (2016). Comparison of zoo animal behavior in the presence of familiar and unfamiliar people. Journal of Applied Animal Welfare Science, 19, 234-244.

Meehan, C.L., Mench, J.A., Carlstead, K., Hogan, J.N., Brown, J., Morfeld, K., Winckler, C., Forkman, B., Dimitrov, L., Langbein, J., Bakken, M., Vessier, I. & Aubert, A. (2016). Determining connections between the daily lives of zoo elephants and their welfare: an epidemiological approach. PLoS One, 11(7): e0158124. https://doi.org/10.1371/journal.pone.0158124

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

Melfi, V. & Hosey, G. (2019). The importance of HAIs, HARs and HABs. In: Hosey, G., Melfi, V. (Eds.), Anthrozoology; Human-Animal Interactions in Wild and Domesticated Animals. Oxford University Press, Oxford, UK, 2019; pp 142-161.

Miller, S.C., Kennedy, C., DeVoe, D., Hickey, M., Nelson, T. & Kogan, L. (2009). An examination of changes in oxytocin levels in men and women before and after interaction with a bonded dog. Anthrozoös, 22, 31-42.

Patel, F., Whitehouse-Tedd, K. & Ward, S.J. (2019). Redefining human-animal relationships: an evaluation of methods to allow their empirical measurement in zoos. Animal Welfare, 28 (3).

Preto-Previde, E., Custance, D.M., Spiezio, C. & Sabatini, F. (2003). Is the dog-human relationship an attachment bond? An observational study using Ainsworth's strange situation. Behaviour, 140, 225-254

Russow, L.-M. (2002). Ethical implications of the human-animal bond in the laboratory. ILAR Journal, 43, 33-37.

Serpell, J. A. (1996). Evidence for an association between pet behavior and owner attachment levels. Applied Animal Behaviour Science, 47, 49-60.

Serpell, J. A. (2019). Companion animals. In: Hosey, G., Melfi, V. (Eds.), Anthrozoology; Human-Animal Interactions in Wild and Domesticated Animals. Oxford University Press, Oxford, UK, pp 17-31.

Stephens, M.B., Wilson, C.C., Goodie, J.L., Netting, F.E., Olsen, C.H. & Byers, C.G. (2012). Health perceptions and levels of attachment: owners and pets exercising together. Journal of the American Board of Family Medicine, 25, 923-926.

Virués-Ortega, J. & Buela-Casal, G. (2006). Psychophysiological effects of human-animal interaction: theoretical issues and long-term interaction effects. Journal of Nervous and Mental Disease,, 194, 52-57.

Waiblinger, S. (2019). Agricultural animals. In: Hosey, G., Melfi, V. (Eds.), Anthrozoology; Human-Animal Interactions in Wild and Domesticated Animals. Oxford University Press, Oxford, UK; pp 32-58.

Ward, S.J. & Melfi, V. (2013). The implications of husbandry training on zoo animal response rates. Applied Animal Behaviour Science, 147, 179-185

Ward, S. J. & Melfi, V. (2015). Keeper–animal interactions: Differences between the behaviour of zoo animals affect stockmanship. PLoS ONE, 10(10): e0140237. https://doi.org/10.1371/journal.pone.0140237.

Wielebnowski, N.C., Fletchall, N., Carlstead, K., Busso, J.M. & Brown, J.L. (2002). Noninvasive assessment of adrenal activity associated with husbandry and behavioural factors in the North American clouded leopard population. Zoo Biology, 21, 77-98.

Zimmerman, C., Chen, Y., Hardt, D. & Vatrapu, R. (2014). Marius, the giraffe: a comparative informatics case study of linguistic features of the social media discourse. In Proceedings of the 5th ACM international conference on Collaboration across boundaries: culture, distance & technology, pp. 131-140.

Table 1. Summary of outcomes of the multiple regression of ZA and PA scores across the whole sample.

predictor	**ZA scores**	**PA scores**
location	p<0.01	ns
gender	p<0.05	p<0.001
age group	ns	ns
years as keeper	ns	-
years with animal	p=0.01	ns
view of zoo bonds	ns	-
taxon	ns	p=0.001

Figure legends

Figure 1. Mean ZA scores for the different taxon groups in which respondents reported a bond.

Figure 2. Mean PA scores for the different pet animal taxa with which respondents reported having a bond.

Figure 3. Mean ZA scores for the different zoos in the survey.

Figure 4. Mean PA scores reported by respondents for the different zoos in the survey.