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The implications of husbandry training on zoo animal response rates

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ABSTRACT

Positive reinforcement training (hereafter known as training) has increasingly been adopted in zoos, to facilitate complex veterinary procedures without sedation or restraint and support husbandry requirements. However, empirical studies to establish the efficacy of training or investigate its impact on keeper–animal relationships are scarce; this was the topic of the current investigation. Study animals were classified as formally trained (FT) partially trained (PT) or untrained (UT). Eight black rhinoceros (2FT, 2PT & 4UT), twelve Sulawesi crested black macaques (4FT, 4PT & 4UT) and eleven Chapman zebra (4FT, 2PT & 5UT) were studied in 6 zoos across the UK and USA. Subtle cues and commands provided by keepers directed towards the animals were identified and the latency between these and the respective behavioural responses (cue-response) were recorded. Animal personalities were also assessed using trait ratings completed by keepers for each animal. Social species (zebra and macaques) responded quicker to cues than the solitary species (rhino; $F_2 = 13.716$, $p < 0.001$). FT animals responded quicker to keeper cues than PT and UT animals ($F_{2,22} = 6.131$, $p < 0.01$). There was no significant difference in the cue-response latencies according to personality traits ($Z = -1.576$, $p > 0.05$). Data suggested that trained group living animals had reduced latencies when reacting to keeper's cues, regardless of their personality. If we consider short cue-response latencies to be indicative of low fear, then we suggest that training can potentially reduce animals' fear of humans thus could contribute to positive keeper–animal relationships which in turn could lead to improved animal welfare.

1. Introduction

Hemsworth and Coleman (1998) investigated human–animal interactions between stock-keepers and farm animals which explored how human–animal relationships formed in this context. Data demonstrated a significant negative correlation between 'stress' and fear of humans, and productivity for pigs and cattle (Boivin et al., 2003; Hemsworth, 2003; Waiblinger et al., 2002). Hemsworth (2003) reported that fearfulness (towards stock-keepers), could be reduced if the animals were exposed to positive human interactions, such as petting or positive communication. Boivin et al. (2003); Hemsworth et al. (2000) and Lensink et al. (2001) further noted that "good stock-keepers" had a positive attitude towards the animals they worked with, described the animals in a positive manner and created positive human–animal interactions e.g. patting or stroking.

Keeper–animal relationships in zoos have been measured using positive interactions between the keepers and animals (Carlstead, 2009). Baker (2004) assessed the

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effects of positive human–animal interaction in the form of relaxed treat feeding, playing, and other forms of social interaction compatible with personnel safety, on the behaviour of adult chimpanzees. When the chimpanzees experienced more 'positive' time with their keepers, they performed significantly less self directed displacement behaviours, such as regurgitation/re-ingestion, and their percentage time spent inactive decreased. Manciocco et al. (2009) found similar results with common marmosets where increased positive human–animal interaction resulted in increased allo-grooming and increased play behaviour bouts. Carlstead (2009) proposed that if zoo housed animals experienced positive human–animal interaction they would be less fearful of people. Furthermore, she suggested this lower level of fear might manifest itself in the animals' reduced latency to perform an appropriate behaviour in response to a keeper cue or command.

Human–animal interactions may also be affected by the animals' personality, which has been identified and described in various animal taxa using various methods including trait constructs and uses either behavioural codings or trait ratings (Gosling, 2001). Animal personality can be assessed by surveying keepers, who know the animals, and by asking them to rate these animals on various behavioural traits; they are provided with terms and definitions and have to determine how well these fit to the animal (Wielebnowski, 1999). Personalities have been measured in many taxa including fish (*Lepomis gibbosus*, *Gasterosteus aculeatus*), reptiles (*Thamnophis sp*), birds (*Parus major*, *Taeniopygia guttata*) and mammals including many non-human primates (*Macaca mulatta*, *Macaca fuscata*, *Pan troglodytes*; See Gosling, 2001 for an extensive review). Personality traits such as boldness and fearfulness have been measured and could suggest that a potentially fearful animal may be naturally fearful of humans, which could make them difficult to manage in a captive zoo setting.

A way to increase the positive human–animal interactions between the keepers and the animals that they work with could be the use of positive reinforcement training (hereafter known as training). This is the presentation of a stimulus after a behaviour that serves to maintain or increase the frequency of that behaviour (Heidenreich, 2007). It has become more commonly used within zoo animal husbandry to facilitate veterinary and husbandry procedures (Laule et al., 2003; Young & Cipreste, 2004). Pomerantz & Terkel (2009) investigated the effects training had on the psychological welfare of zoo-housed chimpanzees (*Pan troglodytes*). The training regime lasted approximately 5–10 min per individual and included them touching and holding onto a target which then progressed onto the animals presenting areas of their body such as their feet, back, hands, head and then receiving a food reward. The training was included in the chimpanzees' daily routine to aid husbandry and veterinary procedures. Results comparing abnormal behaviours including coprophagy, painting with faeces, drinking urine, plucking hair and sterotypies; indicative of poor psychological welfare, showed that the presence of training in their routine decreased these behaviours. Social affiliative behaviours between individuals were also monitored and found to increase significantly once the training was part of the routine. They concluded that the training offered to the chimpanzees had a positive impact in reducing abnormal behaviours, they were less tense, spent less time idle and more time engaged in affiliative behaviours and that the training influence lasted throughout the day irrespective of the behaviours that were directly trained. However, the chimpanzees used within this study were housed in small, barren indoor areas for around 15 h per day. It could be that the positive effects noted within this study may be less beneficial on animals housed in more complex and stimulating enclosures.

Melfi and Thomas (2005) measured the effects of training on a social group of Abyssinian colobus monkeys (*Colobus guereza*). The animals were undergoing a training regime to increase the efficiency of a worming treatment however, as a consequence the training acted to reduce human-directed behaviour from the animals without unduly influencing activity levels or social interactions within the social group (Melfi and Thomas, 2005).

Hosey (2008) proposed a human–animal relationship model, for zoo animals, suggesting that an animal which was fearful of humans may have encountered negative interactions and therefore formed a negative human–animal relationship or no human–animal relationship at all. By contrast, animals experiencing positive human–animal interaction would develop low fear of humans and therefore be confident or enriched by people i.e. the animals would develop a positive human–animal relationship or no human–animal relationship respectively. With this in mind, the use of training with zoo housed animals could increase the positive human–animal interactions and therefore help to decrease the fear of humans that animals may experience from either unfamiliar (visitors) or familiar (keepers) people. The aim of this study was to investigate if training had a positive effect on the keeper–animal interactions and therefore keeper–animal relationships of different zoo housed animals.

2. Methods

2.1. Subjects, housing and husbandry

Eight black rhinoceros (*Diceros bicornis*) aged between 6 and 10 years old, eleven Chapman's zebra (*Equus burchellii*), aged between 4 and 8 years old; and twelve Sulawesi crested black macaques (*Macaca nigra*) aged between 3 and 12 years old were studied, ensuring that only adults were included in data collection. The animals were maintained in five British and one American zoo, and were categorised as: (a) un-trained, UT, (b) partially trained, PT or (c) formally trained, FT (Table 1). UT did not receive 'conscious' cues/commands but may have become trained by unconscious cues/commands. PT did not have a formal training programme but keepers' provided consistent cues/commands and expected an appropriate and consistent response. FT animals had undergone, or were part of, a formal 'goal orientated' positive reinforcement training programme involving food rewards to encourage behaviours such as presenting sections/areas of their body to enable veterinary checks or procedures to be completed.

Table 1
Division of species at the different institutions showing numbers of males and females (M and F) and whether they were classified as trained (FT), partially trained (PT) or untrained (UT) individuals.

	Diceros bicornis		*Equus burchellii*		*Macaca nigra*	
	M.F	Training	M.F	Training	M.F	Training
Paignton	1.1	PT	–	–	2.2	UT
Chester	2.2	UT	–	–	–	–
London	–	–	2.2	FT	2.2	PT
Colchester	–	–	2.3	UT	–	–
Newquay	–	–	2.0	PT	2.2	FT
Atlanta	1.1	FT	–	–	–	–

Study animals were selected to include different mammal species that were managed under the three conditions of interest (untrained, partially trained and trained) and were held in the same institutions; the latter enabled us to test whether 'zoo' (the location that the animals were maintained in) contributed to any differences in behaviour observed, in absolute terms and relative to the variables tested i.e. training level, species, sociality.

All of the enclosures within each institution were cleaned each morning before the zoo opened to the public. This procedure involved cleaning the outdoor enclosure whilst the animals were locked indoors, then the animals were moved to their outdoor enclosure and the vacated indoor enclosure was cleaned; the time access was provided between the indoor and outdoor enclosure areas varied between zoos.

2.2. Data collection

2.2.1. Behavioural observations

Keeper–animal interactions were observed over the course of a keepers' working day (approx. 8 h) for each species at each zoo ($N = 9$). The first 2 h (08.00–10.00 am), and last hour (16.00–17.00 pm) of the keepers' day were consistently identified as the period of highest keeper–animal interactions; when animals were being moved around their enclosures.

Keepers were selected according to their shift patterns to ensure that a suitable amount of data was collected and that there was enough data per keeper–animal dyad. All keeper cues/commands visible to the observer (visual, auditory, contextual), directed to towards all of the study animals and the animals' respective behaviours were recorded; three cues/commands common to all species and zoos, which were not part of a training programme were selected for comparison. Experiment cues/commands (hereon cues/commands) were: (i) a keeper approaching the enclosure without calling the animals name to which the animal responds in recognition; (ii) the keeper 'asking' the animal to move to the outside enclosure from the inside enclosure; (iii) and the keeper 'asking' the animal to move to the inside enclosure from the outside enclosure. All occurrences of the cues/commands and respective behaviours were recorded using live observations with the latency to perform the behaviour being the time taken from when the cues/command was given, to when the correct behaviour was performed by the focal animal. The socially grouped animals were recorded per individual animal. At each institution, 3 animal-keeper dyads were observed. Latencies for each animal to perform the required behaviour following all of the cues/commands were recorded per keeper–animal dyad. Each cues/commands per keeper–animal dyad was recorded 8 times.

2.2.2. Behavioural profiling

Data were collected using a questionnaire following the recommendations set out in the BIAZA Behavioural Profiling Guidelines (Pankhurst et al., 2009). The questionnaire asked keepers to rate the animals in their care, according to how they behaved with reference to four main traits: boldness, adaptability, fearfulness and interactivity with humans (Knight et al., 2009). The questionnaires were completed for each keeper–animal dyad and followed a Likert scale design from 1–7; where 1 signified the trait not being present in the animal and 7 signifying the trait strongly being represented in the animal.

Personality data was unavailable at all of the institutions housing *D. bicornis* therefore this data was omitted from the analysis for this species.

2.3. Data analysis

Keepers were told that the study focused on diurnal activity budgets of the animals and were not fully aware of the hypothesis. Keepers' knowing that their behaviour was being observed may have distorted their behaviour or interactions with the animals and could have affected how they ranked them in the personality questionnaires. A full debriefing with results was provided retrospectively, data remained anonymous and the keeper and animal identities were not acknowledged in data analysis or interpretation of the results.

Latencies for the three cues/commands were normally distributed and averaged per cue/command, and per individual animal rather than per animal–keeper dyad to analyse the response of the animal rather than how it performs for different keepers. Behavioural results were analysed using a three (species: macaque, zebra, rhino) by three (training: UT, PT and FT) ANCOVA design with institution as a covariate. Two contrasts were performed using contrast coefficients to show differences between some of the independent variables. These included social (*E. burchellii* and *M. nigra*) versus non-social (*D. bicornis*) species, and formally trained animals versus non-formally trained animals (UT and PT).

Personality traits were ranked per animal and scores for each trait were calculated taking into account each keeper–animal dyad score. Differences in personality traits scores were analysed using Wilcoxon tests to investigate any differences the individuals at each training level.

3. Results

There were significant differences in cue-response latencies between species ($F_{2,22} = 25.017$, $p < 0.001$) with the slowest latency to perform the appropriate response being 33.48 ± 6.55 s for the *D. bicornis* and the quickest was 12.89 ± 0.92 s for the *M. nigra*. Contrast coefficients performed to separate social and solitary species highlighted that social species (*E. burchellii* and *M. nigra*) reacted significantly faster to cues/commands than the solitary species (*D. bicornis;* $F_{2,22} = 13.716$, $p < 0.001$).

There was also a significant difference between cue-response latencies according to training condition; UT animals performed tasks significantly slower ($F_{2,22} = 10.166$, $p < 0.01$) than the FT animals (means: 24.2 ± 6.14 s and 11.37 ± 0.73 s, respectively). Contrast coefficients demonstrated that FT animals were significantly faster to perform the required behaviours after cues/commands, compared to PT and UT ($F_{2,22} = 6.131$, $p < 0.001$).

The interaction between training condition and species was also significant ($F_{3,\,22} = 8.411$, $p < 0.01$) which indicated that the latencies to respond across the species varied between the different training levels (Fig. 1). Overall, the PT and UT animals showed latencies which were extremely varied according to species, ranging from an average of 13.57 s (*M. nigra*, UT) to 48.13 s (*D. bicornis*, PT). However, all species which underwent FT had a much lower range of latencies to perform the required behaviours with an average of 8.96 s (*M. nigra)* to 13.24 s (*E. burchelli).* Interestingly the *M. nigra* were the species which on the whole had the lowest range of latencies to perform the required behaviours (8.96–14.98 s).

There were some significant differences between the behavioural traits of different individuals at the same and different institutions (Table 2), however, there was no significant difference in the cues/command response latencies according to the behavioural traits of the individuals (Wilcoxon: $Z = -1.576$, $p > 0.05$).

4. Discussion

Results suggest that the species studied, responded in different time scales to the cues/commands required by a keeper. This implies that even the untrained animals recognised what the keepers required and performed the correct response. This supports the idea that animals in captivity are continually learning from their daily husbandry routine and it may be beneficial for them to experience novel routines to increase the variability they experience (Laule, 2003). The results also showed that the social group living animals performed the required behaviours significantly quicker than the solitary animals ($F_{2,22} = 13.716$, $p < 0.001$). This could be due to social facilitation meaning that once one individual performs the required behaviour, the others follow this reaction of the specific member of the group possibly due to a degree of confidence and social support (Zentall, 2006). Overall it was the *M. nigra* species which had the quickest response time t react to keepers cues/commands. This could be linked to the species' social structure and that they are more commonly housed in groups of more than 5–6 individuals compared to the other social animal studied. Social facilitation within the capacity of this study could be seen as beneficial as all training groups (FT, PT and UT) of animals performed the required behaviours requested by the keepers in a reasonable time. However, it is possible that this response may depend upon the confidence of the dominant individual who is more likely to initiate the behavioural response. In this study, the quickest response times were seen by the PT and FT groups of *M. nigra* which are both dominated by 'bold' individuals.

Animals that were part of a formal, goal orientated training programme were significantly quicker to respond to generic cues and commands required by the keepers. This could be linked to the increased positive Keeper–animal relationships formed during the training regime. Baker (2004) and Manciocco et al. (2009) showed that if a keeper increases the amount of time spent with the animals they cared for it can have a positive influence on the animals' behaviour. However, positive animal behaviour has also been linked to the use of trining (Melfi and Thomas, 2005; Pomerantz and Terkel, 2009; Shyne and Block, 2010). From the results of this study, it is difficult to suggest whether it is the PRT which is increasing the positive behaviours from the animals or the extra time that the keepers spend with them due to the training regime. However, it is clear to see that the effect of training is of benefit to the animals and that it does help to increase the positive keeper–animal relationships formed as suggested by Carlstead (2009). Further research into this area would help to clarify whether the major impacting factor is the increase in positive interactions or simply just more time being spent with the animals. Results from this research could have huge implications on a zoo keeper's daily routine.

The measurement of animal personalities has been discussed in many species and has shown differences in maternal behaviour, grooming preferences, activity budgets and an animal's approach to learning (Rouff et al., 2005). The results within this study suggest that between the animal studied at each institution, there were differences in the personality traits measured. Some individuals were significantly bolder than others within the social group and some significantly more fearful. However, results suggested that even fearful individuals that took part in training showed significantly quicker responses to cues/commands provided by the keepers. It was suggested that short cue-response latency could indicate low fear reaction (Carlstead, 2009; Hosey, 2008) results which therefore demonstrate that the effect of training reduces the impact of the animals fearful personality and could reduce an animals' fear of humans within a captive setting which has also been seen as a result of environmental enrichment (Meehan and Mench, 2002).

Hosey (2008) created a model which explored different human–animal interactions and their consequences for human–animal relationships in zoos. He suggested that an animal that experienced negative interactions with humans would either develop a negative relationship or no relationship at all with that human. This would therefore lead to a fearful animal and which would possibly

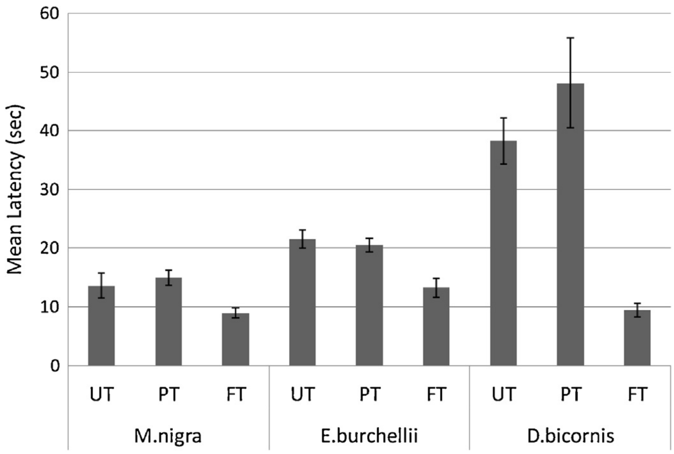

Fig. 1. Mean latencies (±SE) of the three species undergoing different training levels where UT means untrained, PT means partially trained and FT meaning formally trained.

avoid contact with humans. On the other hand, animals that experienced positive interactions would develop a positive or again, no relationship which could lead to the animal experiencing low fear and being enriched by humans. The research presented shows zoo animals' response rate to keeper cues increases in tandem with their level of training. It is suggested that zoo training programmes which are undertaken with due care and biased towards positive reinforcement, as observed in this study, reduces fear in animals of humans; a fundamental requirement for neutral or positive human–animal relationships (Hosey, 2008). Whether fear is reduced in animals by the prolonged duration of human interaction, close proximity with humans, the food reward or because no negative consequences occur during the training session, is unclear and requires empirical investigation.

Stockmanship within a farm animal setting has been continually shown to affect the behaviour and productivity of cattle and pigs (Boivin et al., 2003; Hemsworth, 2003; Waiblinger et al., 2002). Research suggested that negative stockmanship led to negative behavioural performances and therefore decreased productivity. Within a zoo setting, it is however not feasible to record negative keeper–animal interactions as they were not observed during this study; they also could not be requested as this would have ethical implications. Therefore, positive interactions were

Table 2
Personality scores on a scale of 1–7, (where 1 suggests the trait is not represented in the animal at all and 7 suggests that the trait is strongly represented in the animals) according to species and training levels where * indicates a significant difference ($p < 0.05$) between the individuals within each training level. Personality scores were unavailable for *D. bicornis*.

					Personality Score			
Species	Training level	Individual	Sex	Age (yrs)	Boldness	Adaptability	Fearfulness	Interactive
Macaca nigra	FT	Ty	Male	10	6.3*	6.6*	4.5*	6.4*
		He	Female	19	3.2	3.2	6.3	2.1
	PT	Im	Female	18	2.7	2.4	6.1	4.4
		Pu	Male	5	2.4	3.1	6.6	4.2
	UT	Ga	Male	12	6.6*	2.8	3.8	5.6
		Wi	Female	19	2.8	6.3	6.3	5.8
		Sa	Female	15	3.2	5.8	6.2	3.6
		Ma	Female	7	1.5	3.3	3.9	6.3
		Mi	Male	19	5.1	3.2	6.6*	6.7*
		Ve	Male	10	2.3	4.6	2.2	2.4
		Ia	Male	11	4.1	2.2	3.6	3.7
		Ch	Male	8	2.4	6.6*	2.7	1.2
Equus burchellii	FT	Fr	Male	24	6.6	6.6*	1.1	5.7
		Eb	Male	2	5.8	2.8	1.6	6.2
	PT	Zo	Female	21	3.1	1.3	6.3*	6.2
		Ko	Male	2	6.4	1.5	2.6	4.5
	UT	Zi	Female	4	3.8	3.2	2.3	6.8
		M'Ze	Female	4	2.7	6.7	6.4*	2.2
		Tr	Male	19	6.4*	4.8	3.8	6.4
		Do	Female	18	5.6	6.3	6.2	6.1
		Da	Female	18	4.2	5.6	1.3*	2.8*
		K'Tu	Female	4	2.8	6.2	6.5	6.1
		Zu	Female	5	1.2	2.3	6.5	6.1

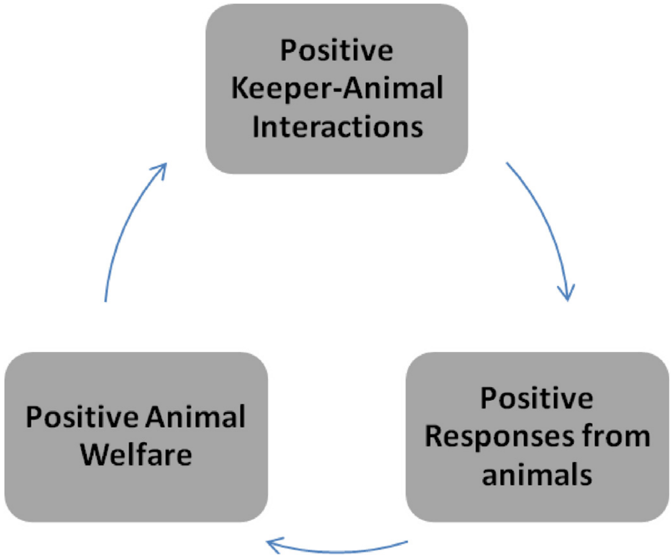

Fig. 2. Zoo stockmanship cycle devised for keeper–animal relationships that are formed within a zoo setting.

recorded and results supported a "zoo stockmanship cycle". This cycle being self-perpetuating where, as the correct behavioural response is performed by the animals will reinforce positive keeper–animal interactions from the keepers, and so it goes on. In this manner, animal welfare can be promoted in zoos by positive keeper–animal interactions leading to positive behavioural responses in the animals (Fig. 2).

5. Conclusion

Training reduced the latencies to respond to a keepers' cues for both of the social species studied in this context (Chapman zebra and Sulawesi macaques). This pattern could be linked to the social facilitative learning aspect of group living but could be useful within a captive zoo setting. Training can be used to increase the positive keeper–animal interactions which underpin positive keeper–animal relationships within a zoo setting and may help to mitigate an animal's fearfulness of humans.

Stockmanship can have a huge impact on the behaviour of zoo housed animals. The Zoo Stockmanship Cycle suggests that positive keeper–animal interactions can lead to increases in zoo animal welfare.

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