Author for correspondence:
Robert John Young
e-mail: r.j.young@salford.ac.uk

Royal Society Publishing

Rapid animal welfare assessment: an archaeological approach

Ivana Gabriela Schork[1] and Robert John Young[1,2]

[1]Conservation, Ecology and Animal Behaviour Group, Prédio 41, Mestrado em Zoologia, Pontifícia Universidade Católica de Minas Gerais, Avenida Dom José Gaspar, 500, Coração Eucarístico, 30535-610 Belo Horizonte, Minas Gerais, Brasil
[2]School of Environment and Life Science, University of Salford Manchester, Peel Building, Salford M5 4WT, UK

The welfare of an individual depends on its capacity to overcome suboptimal conditions in its environment; otherwise, its physical and psychological health becomes compromised. A situation that clearly indicates lack of control of the environment is the expression of abnormal behaviours, such as stereotypies. This study aimed to verify the well-being of police horses using a new rapid form of welfare assessment: an archaeological approach. To this end, we sampled and quantified marks found on the stables, deposited as a result of abnormal behaviour. We cross-referenced these physical marks with veterinary records of diseases, such as colic, known to be associated with stress. A total of 46 horses were sampled and the results showed a significant medium-strength, positive correlation between bite mark frequency on stable doors and the incidence of colic. A weak significant positive correlation was found between length of scratch marks (from pawing) and the incidence of lameness. We conclude that these marks reflect the accumulated expression of abnormal behaviour and can provide rapid insight into the welfare of individual animals.

1. Introduction

The welfare of an individual depends on its capacity to overcome suboptimal conditions in its environment in order to maintain its physical and psychological health [1,2]. One indication that an animal's welfare has been compromised is its performance of abnormal behaviours such as stereotypies—behaviours of invariant type which lack apparent function. The display of stereotypies has been shown to be related to the lack of control that an animal has over its environment [3–5]. Animals in such situations are predisposed to develop a variety of stress-related diseases [6–9].

A current major challenge for animal welfare is to develop rapid welfare assessments; this is important if the well-being of the huge numbers of animals in captivity is to be monitored. While scientists have devised a variety of behavioural and physiological methods to assess animal welfare, most suffer from one of two problems: they are either too invasive, time consuming or both to be applied in practice [5,10]. Studies have shown that it is easier to avoid animal welfare problems than treat them once they have arisen [10,11]; thus, there is a clear need for rapid, practical methods of assessing animal welfare.

The expression of abnormal behaviours such as crib-biting, wind sucking or repetitive licking leaves distinctive marks on animal enclosures [8,9] (figure 1). These marks may accumulate over time and provide insight into the well-being of the individual that made them, providing the basis for a rapid welfare assessment approach. We investigated this hypothesis by examining the correlation between marks resulting from abnormal behaviour and the incidence of colic, a known stress-related condition [12,13], in police horses.
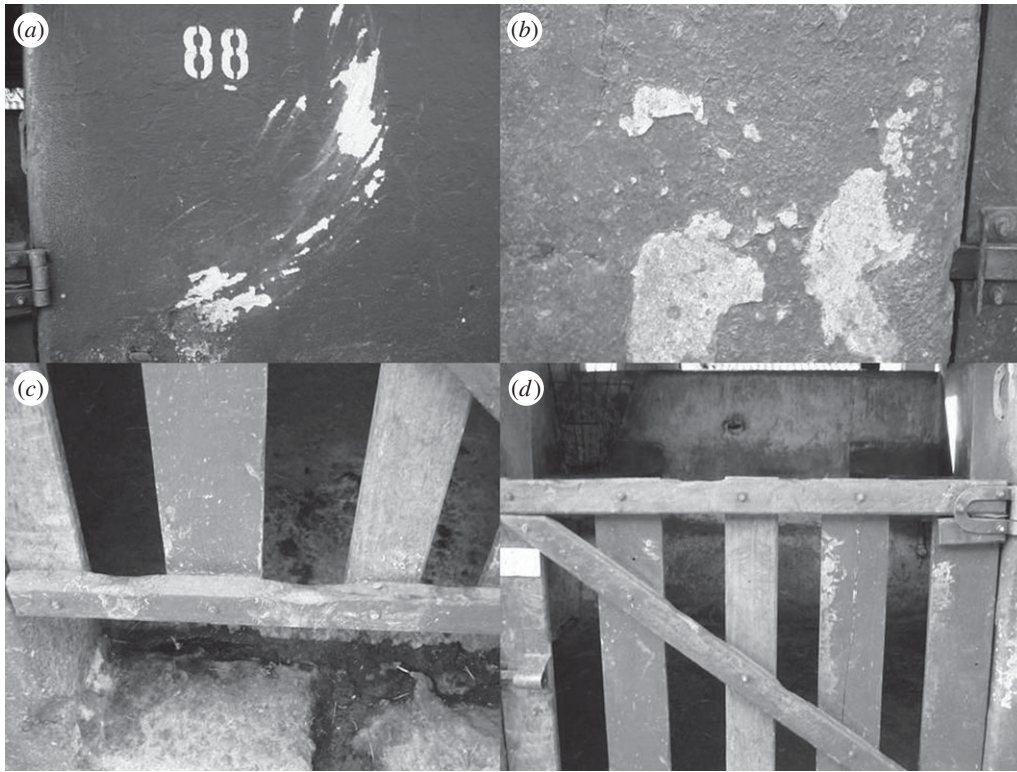
Figure 1. Characterization of marks left by the expression of abnormal behaviours on a stable in the Military Police HQ, Belo Horizonte, MG, Brazil. (*a,b*) Licking spots; (*c*) bite marks and wearing of the stone due to pawing; (*d*) bite marks and scratches from teeth. Source: Ivana Schork.

2. Material and methods

We chose as our model species domestic police horses, as captive horses show an individual prevalence of 18.4% of performing abnormal behaviour [4] and studies have shown a strong connection between the behaviours of wind sucking (holding on to a stable structure with the teeth and swallowing air in large gulps) and crib-biting and the occurrence of colic in this species [12,13], which is a major cause of death in horses [14].

We studied 46 police horses housed at the military police headquarters in Belo Horizonte, Minas Gerais, Brazil (figure 2). These animals were of both sexes with an average age of 10.37 ($\pm$0.67) years; they were used for urban patrolling. All horses were strictly maintained under identical housing, feeding regime, husbandry procedures and exercise routine. They were monitored daily by veterinary staff for physical health problems. Our study population was investigated, prior to our study, for the occurrence of abnormal behaviours, such as crib-biting, and returned a mean rate of 29.2% of expression of these behaviours [15]. In addition, the population exhibited a high rate of colic per horse per year [16] and the incidence of colic was four times more likely in animals expressing abnormal behaviour than in those that did not [15].

All the stables had been repainted and refurbished at the same time, 2 years prior to this study, and all the subjects remained in the same stalls over this period.

To investigate the potential connection between abnormal behaviour and well-being in these horses further, we conducted a survey of all licking spots, bite marks and other evidence of stable damage resulting from abnormal behaviour (figure 1). The veterinary records of all the individuals, during the entire period as patrol horses, were analysed to quantify frequencies of diseases known to be associated with stress, such as colic, a known problem in this population [16]. For each stable, we counted licking spots and bite marks. We measured the length and width of the spots with a ruler (accuracy of 0.5 mm) and calculated their area. In addition, we measured scratch marks associated with pawing the ground. In the veterinary records,

we selected data regarding episodes of colic and lameness whose cause was unknown by the veterinary surgeon and discarded those cases with known non-stress-related causes. With this information, we created a disease rate using the total of veterinary records divided by the numbers of the years the horses were stabled. This rate was calculated separately for number of colic cases and number of lameness cases, providing the number of cases/year per animal and the mean number of cases for all horses.

Because neither the raw data nor transformations were normally distributed, we used Spearman rank correlation to assess the association between disease rates and marks present on the stalls. We correlated disease rates with total and individual values per horse for physical characteristics of marks resulting from abnormal behaviour. All analyses were carried out using MINITAB v. 16.1.1 (Minitab Inc. 2010).

3. Results

Of the study population, only 12 animals had no records of the investigated diseases with cause listed as unknown by the veterinarian. A further four individuals had no marks on their stables or records of lameness or colic whose cause was unknown by the veterinarian. A total of 131 colic occurrences and 25 lameness cases were found. The maximum number of records of colic for a single individual was 30; the maximum number of cases of lameness for a single animal was nine. The mean rate of colic was 2.84 ($\pm$0.437) per animal and the population rate was 0.29 cases per year per animal. For cases of lameness, the mean rate was 0.54 ($\pm$0.126) per animal and the population rate was 0.03 cases per animal per year.

The survey on the stables found a total of 96 bite marks 111 licking marks, with a mean area of 272.8 cm^2 ($\pm$29.1) and 24 scratch marks, with an mean length of 6.76 cm ($\pm$1.38).

Figure 2. Overview of the stables belonging to the military police of Minas Gerais, Belo Horizonte, Brazil. Source: Ivana Schork.

We found a positive and significant medium-strength correlation between bite mark frequency and the incidence of colic ($r_s = 0.548$, $N = 46$, $p < 0.001$); likewise the lameness rate had a weakly positive relationship with the length of scratch marks ($r_s = 0.272$, $N = 46$, $p = 0.004$).

There were no significant associations between cases of colic and frequency of licking spots ($r_s = 0.023$, $N = 46$, $p = 0.809$), the area of the spot ($r_s = 0.014$, $N = 46$, $p = 0.887$), spot width ($r_s = -0.029$, $N = 46$, $p = 0.766$) or spot length ($r_s = 0.039$, $N = 46$, $p = 0.686$).

4. Discussion

In our study, a medium-strength correlation was found between the number of bite marks on stables resulting from abnormal behaviour and cases of pathology. Thus, physical evidence left by the expression of certain abnormal behaviour seems to be indicative of the individual's welfare state. This is not surprising given that such marks accumulate over time and the more an animal expresses a particular behaviour the greater the probability that it will leave distinctive physical marks [3,17]. Thus, these marks permit us to dig into the individual's welfare history. The marks on the stables not only confirm the expression of abnormal behaviour by the horses, a fact previous established [15], but they also represent a clear indication that welfare is compromised. Beyond the association with the colic cases we found, other studies indicate that behaviours such as crib-biting and swallowing air have serious deleterious effects on animals' health,

being associated with changes in gastrointestinal motility, stomach acidity and heart rate, colic, gastric ulcerations and dental problems, among others [8,18–21]. This archaeological approach therefore has potential for rapid animal welfare assessment [22]: it is neither time consuming, invasive nor needful of specially trained staff.

We are not suggesting that *all* of the variation in the physical marks resulting from the expression of abnormal behaviour is associated with animal welfare; clearly, there is likely to be individual variation in the marks left by the animals regardless of their welfare differences. However, we have shown here that a significant proportion of the variability in physical marks is associated with variation in welfare.

This method has been overlooked in our opinion because of the difficulty in validating it. The physical marks resulting from the expression of abnormal behaviour have been obvious to the scientific community investigating animal well-being for decades. Zoo animals that leave marks, such as pacing felines or spot-licking giraffes, are usually housed in insufficient numbers to make validation possible and zoo studies suffer from huge variation in housing and husbandry practices [5,11]. This would also be the case for pet horses. By contrast, our population of police horses was essentially managed as a laboratory population (they all came from the same breeding stock) permitting the validation of this technique, especially as their physical health was intensely monitored by veterinarians.

This method will not be a panacea for monitoring the welfare of all captive species, because certain species do not leave marks on their environment when expressing abnormal behaviour (e.g. tongue playing by herbivore species). Also, individuals kept for different periods of time in their enclosure could bias the analyses of the marks as the length of tenure could be mistaken for severity of expression of repetitive behaviour. Despite this, the surveying of marks resulting from abnormal behaviour is a new and efficient tool that may permit the rapid assessment of welfare in a large number of species held in captivity.

References

1. Fraser D. 2008 Understanding animal welfare. *Acta Vet. Scand.* **50**, S1. (doi:10.1186/1751-0147-50-S1-S1)

2. Carenzi C, Verga M. 2007 Animal welfare?: review of the scientific concept and definition. *Ital. J. Anim. Sci.* **8**, 21–30. (doi:10.4081/ijas.2009.s1.21)

3. Mason G, Rushen J (eds). 2006 *Stereotypic animal behaviour: fundamentals and applications to welfare*, 2nd edn. Wallingford, UK: CABI.

4. Mason GJ, Latham NR. 2004 Can't stop, won't stop: is stereotypy a reliable animal welfare indicator? *Anim. Welf.* **13**, 57–69.

5. Dawkins MS. 2003 Behaviour as a tool in the assessment of animal welfare.

Zoology **106**, 383–387. (doi:10.1078/0944-2006-00122)

6. Ursin H, Eriksen HR. 2004 The cognitive activation theory of stress. *Psychoneuroendocrinology* **29**, 567–592. (doi:10.1016/S0306-4530(03)00091-X)

7. Dantzer R. 1991 Stress, stereotypies and welfare. *Behav. Process.* **25**, 95–102. (doi:10.1016/0376-6357(91)90012-0)

8. Wickens CL, Heleski CR. 2010 Crib-biting behavior in horses: a review. *Appl. Anim. Behav. Sci.* **128**, 1–9. (doi:10.1016/j.applanim.2010.07.002)

9. Whisher L, Raum M, Pina L, Pérez L, Erb H, Houpt C, Houpt K. 2011 Effects of environmental factors on

cribbing activity by horses. *Appl. Anim. Behav. Sci.* **135**, 63–69. (doi:10.1016/j.applanim.2011.09.001)

10. Rushen J. 2003 Changing concepts of farm animal welfare: bridging the gap between applied and basic research. *Appl. Anim. Behav. Sci.* **81**, 199–214. (doi:10.1016/S0168-1591(02)00281-2)

11. Whitham JC, Wielebnowski N. 2013 New directions for zoo animal welfare science. *Appl. Anim. Behav. Sci.* **147**, 247–260. (doi:10.1016/j.applanim.2013.02.004)

12. Malamed R, Berger J, Bain MJ, Kass P, Spier SJ. 2010 Retrospective evaluation of crib-biting and windsucking behaviours and owner-perceived behavioural traits as risk factors for colic in horses.

Equine Vet. J. **42**, 686 – 692. (doi:10.1111/j.2042-3306.2010.00096.x)

13. Archer DC, Pinchbeck GK, French NP, Proudman CJ. 2008 Risk factors for epiploic foramen entrapment colic: an international study. *Equine Vet. J.* **40**, 224 – 230. (doi:10.2746/042516408X266079)

14. Archer DC, Proudman CJ. 2006 Epidemiological clues to preventing colic. *Vet. J.* **172**, 29 – 39. (doi:10.1016/j.tvjl.2005.04.002)

15. Leal BB. 2007 *Avaliação do bem-estar dos equinos de cavalaria da Polícia Militar de Minas Gerais: indicadores etológicos, endocrinológicos e incidência de cólica*. Master's thesis, Univesidade Federal de Minas Gerais, Belo Horizonte, Brazil.

16. Leal BB, Alves GES, Douglas RH, Bringel B, Young RJ, Haddad JPA, Viana WS, Faleiros RR. 2011

Cortisol circadian rhythm ratio: a simple method to detect stressed horses at higher risk of colic? *J. Equine Vet. Sci.* **31**, 188 – 190. (doi:10.1016/j.jevs.2011.02.005)

17. Eilam D, Zor R, Szechtman H, Hermesh H. 2006 Rituals, stereotypy and compulsive behavior in animals and humans. *Neurosci. Biobehav. Rev.* **30**, 456 – 471. (doi:10.1016/j.neubiorev.2005.08.003)

18. Sarrafchi A, Blokhuis HJ. 2013 Equine stereotypic behaviors: causation, occurrence, and prevention. *J. Vet. Behav. Clin. Appl. Res.* **8**, 386 – 394. (doi:10.1016/j.jveb.2013.04.068)

19. Bachmann I, Audigé L, Stauffacher M. 2010 Risk factors associated with behavioural disorders of crib-biting, weaving and box-walking in Swiss horses.

Equine Vet. J. **35**, 158 – 163. (doi:10.2746/042516403776114216)

20. Nagy K, Bodó G, Bárdos G, Harnos A, Kabai P. 2009 The effect of a feeding stress-test on the behaviour and heart rate variability of control and crib-biting horses (with or without inhibition). *Appl. Anim. Behav. Sci.* **121**, 140 – 147. (doi:10.1016/j.applanim.2009.09.008)

21. Hothersall B, Nicol C. 2009 Role of diet and feeding in normal and stereotypic behaviors in horses. *Vet. Clin. NA Equine Pract.* **25**, 167 – 181. (doi:10.1016/j.cveq.2009.01.002)

22. Whitham JC, Wielebnowski N. 2009 Animal-based welfare monitoring: using keeper ratings as an assessment tool. *Zoo Biol.* **28**, 545 – 560. (doi:10.1002/zoo.20281)