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Effects of habituation, research and ecotourism on faecal glucocorticoid metabolites in wild western lowland gorillas: Implications for conservation management

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ABSTRACT

Wildlife tourism is proliferating worldwide and has the potential to raise revenue for conservation as well as public awareness of conservation issues. However, concerns are growing about the potentially negative influence of such tourism on the wildlife involved. We investigate the effects of habituation, ecotourism and research activities on levels of faecal glucocorticoid metabolites (FGCMs), a proxy for physiological stress, in wild western lowland gorillas (*Gorilla gorilla gorilla*) in the Central African Republic. We compare FGCMs in three human-contacted groups with those in unhabituated gorillas. We also explore how human–gorilla contact influences FGCMs of a gorilla group undergoing habituation and investigate how measures of general human–gorilla contact, tourism and human proximity influence FGCMs in recently and long-term habituated groups. Two of the three human-contacted groups had higher levels of FGCMs than unhabituated gorillas. The group undergoing habituation had the highest FGCMs, which increased up to 21 days following contacts, suggesting a cumulative FGCM response, in line with descriptions of a hormonal adaptation response to a chronic intermittent stressor. FGCMs in habituated groups were significantly associated with increasing frequency of violation of the 7 m distance rule by observers and with a medical intervention but not with other measures of human pressure. Our findings provide critical information for the management of this, and other, species whose conservation depends on habituation for ecotourism.

1. Introduction

Wildlife tourism is one of the fastest growing sectors of the international tourism market (Fennell, 2012). It has been advocated as a tool to conserve species and habitats and can accrue educational and socio-developmental benefits as infrastructure builds around tourism activities (Williamson and Macfie, 2010). Today's tourists desire close, personal, wildlife encounters and are particularly attracted to endangered species in remote, fragile habitats (Williamson and Macfie, 2010). However, a growing number of accounts document behavioural and physiological alterations in the species encountered (Tadesse and Kotler, 2012; Treves and Brandon, 2005; Semeniuk et al., 2009; Velando and Munilla, 2011), causing concerns that the costs of tourism to the focal organisms may outweigh the wildlife conservation benefits

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(Butynski and Kalina, 1998; Ferber, 2000; Higginbottom et al., 2003).

All animals must cope with unpredictable occurrences, or stressors, in their environments (Cyr and Romero, 2008). A normal vertebrate stress response involves a release of glucocorticoids (GCs) from the adrenal cortex (Selye, 1955), which protects an organism against the effects of acute stress via activation of various behavioural and metabolic processes, and is adaptive in the short-term (Cyr and Romero, 2008; Wingfield and Romero, 2010). Long-term elevation of circulating GC levels is, however, maladaptive, as it is linked to hyperglycaemia, neuronal cell death, and suppression of the immune and reproductive systems (Cyr and Romero, 2008). Moreover, unpredictable, chronic, intermittent stressors, as typified in wildlife tourism contexts, are thought most likely to cause pathology (Boonstra, 2012; Sapolsky, 1992). As extensive research has linked increased GC output to ill-health, GCs in blood or faeces have often been used to monitor individuals and populations in conservation research (Cyr and Romero, 2008; Tarlow and Blumstein, 2007; Wikelski and Cooke, 2006), and are used increasingly to assess the physiological effects of human disturbance and wildlife tourism on the animals concerned (Behie et al., 2010; Creel et al., 2002; Ellenberg et al., 2007; Pineiro et al., 2012; Zwijacz-Kozica et al., 2013).

Like other charismatic mega-fauna, great apes figure highly on wildlife tourism wish-lists (Williamson and Macfie, 2010). Great ape tourism relies on the intentional 'taming', or habituation, of wild animals, which involves exposing the apes to a habituation team, until they become accustomed to daily visits ('contacts'), appearing to pay little attention and showing minimal aggression to humans (MGVP, 2009). In the early stages of habituation apes typically show behavioural indications of an acute stress response (Blom et al., 2004). However, once the apes are behaviourally habituated it is postulated that they no longer perceive the arrival of humans as a threat (Butynski and Kalina, 1998), and thus cease to mount an adrenocortical response. To the best of our knowledge, however, no study has examined the effect of the process of habituation on HPA axis activity in any mammal species.

It is important to test the effects of habituation on the GC response in great apes, and the assumption that habituated apes no longer experience an elevated GC response when visited by humans, as chronically elevated GCs can lead to a reduction in resistance to disease (Cohen et al., 2007). Additionally, the close genetic relationship between humans and other apes renders habituated apes vulnerable to human diseases (Woodford et al., 2002). This is of particular concern, as gorillas appear to be physiologically less resilient to stressful situations compared to other great apes as demonstrated by the low survival rate of gorillas in zoos and sanctuaries (King et al., 2009). Gorilla tourism sites have adopted regulations in an attempt to reduce the negative effects of human contact on habituated gorillas including maintenance of a 7 m distance between humans and gorillas, limiting tourist visits to one hour each per day with a maximum number of people per group, and prohibiting visits to gorillas by people who have visible symptoms of contagious illness. However, these rules are difficult to enforce and often fail, leading experts to suggest that the risks of close-contact tourism may be greater than previously believed (Sandbrook and Semple, 2006). Here, we investigate the impacts of habituation, research and tourism on the GC response of the critically endangered western lowland gorilla (*Gorilla gorilla gorilla*).

Western lowland gorillas range across many of the least developed countries in central and west Africa. The remaining wild population size is estimated to be 95,000 animals and is predicted to decline by 80 % over the next 66 years (IUCN, 2012). Despite long-term efforts to habituate groups at several sites, only four groups can currently be visited by tourists. It can take 4–8 years to habituate western lowland gorillas, unlike mountain gorilla groups which can typically be habituated within a year. Tracking difficulties also mean that habituated western lowland gorillas must be followed closely from dawn to dusk to sustain daily contact with the group. In addition, the paucity of habituated western lowland gorilla groups also means that they often serve the interests of multiple stakeholders, including researchers, funding donors, film crews and photographers, as well as tourists. These pressures increase the risks of physiological stress in western lowland gorillas compared to other apes involved in tourism.

We studied a gorilla group undergoing habituation, a recently habituated group, a long-term habituated group, and non-human-contacted, unhabituated gorillas, to test the following hypotheses and predictions:

Hypothesis 1. Contact with humans elicits a GC response in gorillas, but habituation reduces this response over time. We predict that:

(a) Gorillas undergoing habituation and habituated gorillas exposed to ecotourism and research activities will have higher FGCMs that those that are not exposed to human contact at all.
(b) Gorillas undergoing the process of habituation will have higher FGCMs than habituated gorillas.
(c) Long-term habituated gorillas will have lower FGCMs than more recently habituated gorillas.

Hypothesis 2. The process of habituation is perceived as a threat by gorillas. Based on patterns of FGCM excretion in captive gorillas (Shutt et al., 2012), we predict that:

(a) FGCM levels in gorillas undergoing habituation will peak around 48 h after contact(s) with humans.
(b) FGCM levels in gorillas undergoing habituation will decrease to pre-contact levels after peaking at 48 h post contact with humans, assuming the gorillas are not subjected to other environmental stressors.

Hypothesis 3. Elements of daily contact with humans still elicit a GC response in habituated gorillas. We predict that:

FGCM levels will increase with increasing levels of human–gorilla contact, measured as: amount of daily human–gorilla interaction; amount of close-follow research activities; the total daily number of people in contact with the gorilla group; occurrence of tourism; duration of tourist visits; total number of tourist groups; total daily number of tourists; frequency of humans following gorillas at <25 m; and frequency of humans approaching to less than 7 m (violating the distance regulation).

2. Material and methods

2.1. Study site

We conducted our study at Bai Hokou (33 N 663109, 316187UTM) and Mongambe (33 N 654357, 322606 UTM) study sites, in the Dzanga-Sangha Protected Areas (DSPA) in the Central African Republic (CAR). The DSPA are co-managed by the CAR government, the World Wildlife Fund and the Primate Habituation Programme (PHP). For a more detailed description of the study sites see Carroll (1986). Gorilla habituation aimed at developing ecotourism and research activities at Bai Hokou commenced in 1997. Today, tourists (426 in 2011) can visit a long-term habituated group of gorillas (Makumba) at Bai Hokou and another more