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Zoo visitor effect on mammal behaviour: Does noise matter?

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ABSTRACT

The zoo visitor effect is the change in animal behaviour and physiology in response to the presence of a viewing public. It is thought to result from, amongst other things, visitor generated sound (i.e., noise), but this hypothesis has never been explicitly tested. We tested this hypothesis through observations on the behaviour and enclosure use of 12 mammal species held in 12 separate enclosures at the Belo Horizonte Zoo when exposed to different sound pressure levels (i.e., noise) from the visiting public. Noise pollution levels were significantly higher with the public present and increased with increasing audience size. Species that are more popular suffered greater noise pollution from the zoo visitors. No overall effects on behaviour were found in relation to noise levels, however, analysis of behaviour at the individual level found some significant differences. Notably, half of the individuals increased their vigilance behaviour with increasing sound levels and approximately one-third of individuals increased their movements. These results show that zoo visitors have a negative welfare impact on individual zoo-housed mammals, especially groups of noisy visitors where levels were recorded outside of the recommended limits for human well-being (>70 dB(A)). Thus, zoos need to address this issue, probably, through a combination of visitor education campaigns and acoustic modification to enclosures.

1. Introduction

The zoo visitor effect is the change in behaviour and/or physiological responses of animals in the presence of zoo visitors (Davey, 2006). Such changes are often indicators of poor animal welfare, but, for certain species, human audiences are an enriching interaction (Hosey, 2000; Davey, 2006). Scientific investigations into the zoo visitor effect have been ongoing since the 1980s and have generally considered how the viewing public's behaviour affects the well-being of the animals they are watching (Davey, 2006, 2007). In many of these studies, it is assumed that more people means greater levels of noise (i.e., noise pollution) at animal enclosures. In fact, the link between the visitor effect and sound pollution remains untested.

Modern zoos, first and foremost need to ensure the well-being of the animals in their care. It is from this core activity that the stated goals of the modern zoo in conservation, research, education and entertainment can be achieved (Young, 2003). Despite the common effort to

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Table 1
Mammal species studied and their enclosures at the Belo Horizonte Zoo, Minas Gerais, Brazil.

Enclosure style	Species	Enclosure size (m^2)	Distance animal (m)	Visitation area (m)	Sex
Cage	*Alouatta guariba*	40	1	14	1♂, 3♀
Cage	*Leontopithecus chrysomelas*	29	1	7	4♀
Pit	*Pan troglodytes*	1256	15	100[a]	2♂, 2♀
Pit	*Gorilla gorilla*	2040	3	110[a]	1♂
Island	*Cebus xanthosthernos*	2123	1	50[a]	1♂, 3♀
Pit	*Panthera onca*	1256	15	100[a]	2♂
Pit	*Leopardus pardalis*	1256	15	100[a]	3♂
Cage	*Leopardus pardalis*	70	1	7	1♂, 1♀
Paddock	*Speothos venaticus*	263	1	13	4♂
Paddock	*Loxodonta africana*	7407	1	74[a]	1♂, 3♀
Paddock	*Giraffa camelopardalis*	2100	1	105[a]	2♀
	Kobus ellipsiprymnus				1♂, 2♀
Paddock	*Cervus elaphus*	1027	1	26	2♂, 1♀

Distance animal = minimum possible distance between animal and sound pressure metre (m).
[a] Area of visitation: it is possible to have more than 200 people in front of the enclosure.

improve the animal welfare, zoos can negatively impact the well-being of the animals they house due to inherent aspects as unvarying husbandry routines (Lyons et al., 1997) and exposing the animals to the public (Young, 2003; Davey, 2006, 2007).

The zoo-going public is a potential source of both positive and aversive stimuli for the animals. Previous studies into the zoo visitor effect have largely reported a negative impact on animal behaviour (Mallapur et al., 2005; Sellinger and Ha, 2005) and animal physiology (Hosey, 2000; Davis et al., 2005; Davey, 2006, 2007). For example, some species show less affilitative behaviour (Hosey, 2008) in the presence of the public and in some species stress hormone levels are higher during visitor presence (Davis et al., 2005). Typically, such studies have measured the zoo visitor effect in a poorly quantified manner or using qualitative measurements such as the presence or absence of visitors (Mitchell et al., 1991, 1992), while other studies subjectively categorised visitor behaviour as 'agitated' or not (Wells, 2005) for primate species. These studies provide some insights into the zoo visitor effect; however, a better quantification of zoo visitor impacts would provide greater insights. Sound pressure level metres are now relatively low cost and the principles of measuring and assessing noise pollution have been well established by acoustic engineers (Rossing, 2007) and are now used by biologists (e.g., Duarte et al., 2011).

Zoo visitors are the source of three potential types of stimuli to animals: visual, olfactory and auditory (Young, 2003). Visual and olfactory stimuli are difficult to quantify and measure, not least because there are the emitted stimuli (e.g., colours, movement, smell) and there are the perceived stimuli (i.e., what the animal was observing or smelling). Auditory stimuli are easier to quantify, as they are perceived if the animal is paying attention or not, and their effects, at least on human well-being, are understood (WHO, 1999). Furthermore, there are some studies of noise pollution of the viewing public in zoos, which show negative effects on animal welfare (Owen et al., 2004; Powell et al., 2006). Despite this, we found no zoo studies on sound pollution, which have quantitatively measured noise as a direct consequence of the public's behaviour. Therefore, the aim of this study was to directly measure how sound pollution from the zoo-going public affected behaviour and enclosure use by zoo housed mammals.

2. Methods

2.1. Study area and experimental subjects

This study was conducted at the Belo Horizonte Zoo, Minas Gerais, Brazil (19°51′ S, 44°01′ W) from June 2009 to March 2010. Subjects were 12 different mammal species housed in 12 different enclosures (see Table 1). We chose species known to be popular with visitors such as Chimpanzee (*Pan troglodytes*), and matched them with less popular species such as deer (*Cervus elaphus*) (Ward et al., 1998; Whitworth, 2012). Matching was done across all families and its function was to ensure that we had species, which received large and small zoo visitor numbers.

2.2. General data collection

The Belo Horizonte Zoo is closed to the public every Monday (i.e., this creates the experimental condition: background noise but no public) and receives intense visitation on Tuesdays (free entrance day) and the weekend (i.e., this creates the experimental condition: noise and public). Unfortunately, it was not possible for us to create a condition of background sound level and public (i.e., visitor present but control sound pressure level to be equal to background levels). Therefore, control data; that is, no public influence on sound pressure levels were collected on Mondays, and days with visitor influence on Tuesdays and weekends. On Mondays, background levels of noise observed were due to normal routine zoo maintenance activities (e.g., feeding of animals and cleaning of enclosures). To control for time of day effects, we observed, animals in different enclosures using a Latin square experimental design from 0900 h to 1700 h. Each group of animals in the 12 different enclosures was observed for 10 h without (i.e., background sound condition) and 10 h with the zoo visitors being present (i.e., sound and public condition). We used each enclosure as statistical units for noise pollution sampling ($N = 12$).