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Unravelling Zoo Visitor-Penguin Interactions: Effects on Little Penguin Welfare and Visitor Attitudes and Experience

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Unravelling Zoo Visitor-Penguin Interactions: Effects on Little Penguin Welfare and Visitor Attitudes and Experience.

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Abstract

Modern zoos are heavily reliant on the maintenance of high standards of animal welfare and the provision of positive visitor experiences to operate successfully as zoo-based conservation organisations. Several factors, both animal and environment related, influence the welfare of zoo animals and visitor experience. However, one major influencing factor has been visitor-animal interactions. Understanding the effects of visitor-animal interactions in zoos is critical because zoo animals can encounter frequent, and sometimes intense, interactions with unfamiliar humans that may compromise both animal welfare and visitor experience. Extensive research over the last several decades has shown that visitors can influence the behaviour and welfare of a range of zoo species. These effects have varied from stressful, enriching, or innocuous. However, the inconsistent findings have limited our understanding of the visitor-animal relationship. Furthermore, limited research has been conducted to identify the effects of visitors on understudied taxa such as penguins. The effects of zoo animals on visitor attitudes and their experience also remains poorly understood. Hence, the aim of this thesis was to identify the effects of regulating visitor-penguin interactions on a rarely studied species, little penguins (*Eudyptula minor*), and how these interactions affect visitor attitudes and their experience. A combination of animal behaviour and stress physiology as well as visitor behaviour, attitudes and experience were measured, using an experimental approach to examine the zoo visitor-penguin relationship.

A total of three zoo sites were involved: Melbourne Zoo (Victoria, Australia), Taronga Zoo (New South Wales, Australia) and Wellington Zoo (Wellington, New Zealand). At each zoo, different aspects of visitor contact were regulated as a result of the differing enclosure designs. At Melbourne Zoo, the effects of regulating visitor viewing proximity and behaviour were examined. It was found that the close viewing proximity of visitors primarily affected little penguins. This was shown by an increase in the number of penguins vigilant, huddling and avoiding the visitor viewing area and a reduction in the number of penguins surface swimming when visitors were in close viewing proximity. However, no effect on little penguin faecal glucocorticoid metabolite (FGM) concentrations was found. There was no detrimental impact of regulating the interactions between visitors and penguins using a physical barrier on visitor attitudes and their experience. Also, a positive relationship between penguin behaviour and visitor attitudes and experience was found. The more visible, active, and close to the visitor viewing area penguins were, the more positive visitor attitudes and experience were at Melbourne Zoo.

At Taronga Zoo, the effects of obstructing a single visitor viewing window was examined. Unobstructed visitor contact was found to reduce the presence of little penguins, reduce the number of penguins preening in the water and increase the number of penguins vigilant in the area near the main viewing window when this window was uncovered. There was also a general preference by the penguins for the corner area which was visually hidden from visitors. These results provide evidence of some avoidance of visitors by little penguins at Taronga Zoo. Also, no effect of regulating visitor contact using a visual barrier was found on visitor attitudes and their experience at Taronga Zoo. FGM concentrations were not measured at Taronga Zoo. Lastly, at Wellington Zoo, the effects of the presence and absence of visitors were examined. The presence of visitors was found to reduce the percentage of penguins observed close to the visitor viewing pier which was identified as the main viewing area used by visitors. But there was little effect on other penguin behaviours and FGM concentrations. These results suggest that there was an increase in avoidance of visitors when present by the penguins which suggests close visitor contact may be fear-provoking for these penguins.

The results of this thesis demonstrate that zoo visitors may negatively affect zoo-housed little penguins where visitors may be perceived as fear-provoking, as indicated by increases in behaviours indicative of fear. But the magnitude of the penguins' fear response to visitors varied across zoos. This may be the result of influencing factors including enclosure design, previous experience, genetics, and weather. The most pronounced fear response by little penguins towards visitors was found at Melbourne Zoo, followed by Wellington Zoo and lastly, Taronga Zoo. Penguin fear responses to visitors were most pronounced at Melbourne and Wellington Zoo likely because of the main viewing locations for visitors were generally positioned above the pool. This type of viewing position provided opportunities, if visitors chose, to closely approach and loom over the pool edge which may have been perceived as threatening by the little penguins. In comparison at Taronga Zoo, visitors were positioned below the surface of the pool. Therefore, results from this thesis indicate that the close viewing proximity of visitors, particularly from above, is a common characteristic of visitor contact that little penguins may find fear-provoking.

The overall effect of visitors on the welfare of zoo-housed penguins is somewhat unclear. Despite fear responses towards visitors by little penguins were apparent when visitor contact was uncontrolled, there was no effect of the treatments imposed on FGM concentrations. One interpretation of the lack of treatment effects on FGM concentrations at Melbourne Zoo and Wellington Zoo is that the penguin behavioural responses such as avoidance may have been an effective adaptive response in ameliorating the need for a sustained physiological stress response arising from close

visitor contact. Nevertheless, close visitor viewing proximity may be fear-provoking for little penguins and can be regulated by positioning visitors further away from the enclosure boundary or by reducing the perceived close proximity of visitors for little penguins. This will result in improvements in penguin welfare and have no detrimental effect on visitor attitudes and experience, which were overall positive and enhanced by penguins displaying more active behaviours and less behaviours indicative of fear. However, it is unclear whether these positive attitudes and experience of visitors affected the way visitors behaved towards little penguins.

The results reported in this thesis provide what is believed to be the first comprehensive study investigating the zoo visitor-penguin relationship from both the animal and visitor aspects. This research expands our knowledge on the zoo visitor-penguin relationship, indicating the importance of examining visitor-animal relationships from the animal and visitor perspectives and identifies some practical measures that zoos can utilise to improve the management of visitor-penguin interactions.

Declaration

This is to certify that:

- i. the thesis comprises only my original work towards the PhD,
- ii. due acknowledgement has been made in the text to all other material used and,
- iii. the thesis is fewer than 100 000 words in length, exclusive of tables, maps, bibliographies, and appendices.

Samantha J. Chiew

Preface

The work presented in this thesis is original as declared in text and has been written incorporating manuscripts and accepted publications. This thesis was fully funded by an Australian Research Council Linkage grant (LP140100373) and supported by an Australian Government Research Training Program scholarship. Chapter 1 is an unpublished literature review. Chapter 2, 3, 4, 5 and 6 are published in peer-reviewed journals. All chapters are displayed in their final version. Samantha Joanne Chiew is the first author on all chapters. Assistance given by others has been indicated in the Author Contributions and Acknowledges statement of each chapter.

Publications

Peer-reviewed journals

- Chiew, S.J., Butler, K.L., Fanson, K.V., Eyre, S., Coleman, G.J., Sherwen, S.L., Melfi, V. and Hemsworth, P.H. (2021) 'Effects of the Presence of Zoo Visitors on zoo-housed Little Penguins (*Eudyptula minor*)', *New Zealand Journal of Zoology*, 1-22, available: <https://doi.org/10.1080/03014223.2021.1896560>.
- Chiew, S.J., Hemsworth, P.H., Melfi, V., Sherwen, S.L., Burns, A. and Coleman, G.J. (2021) 'Visitor attitudes towards little penguins (*Eudyptula minor*) at two Australian zoos', *Frontiers in Psychology*, 12(284), 1-13, available: <https://doi.org/10.3389/fpsyg.2021.626185>.
- Chiew, S.J., Butler, K.L., Sherwen, S.L., Coleman, G.J., Melfi, V., Burns, A., and Hemsworth, P.H. (2020) 'Effect of Covering a Visitor Viewing Area Window on the Behaviour of Zoo-Housed Little Penguins (*Eudyptula minor*)', *Animals*, 10(7), 1224-1245, available: <https://doi.org/10.3390/ani10071224>.
- Chiew, S.J., Hemsworth, P.H., Sherwen, S.L., Melfi, V. and Coleman, G.J. (2019) 'The Effect of Regulating Zoo Visitor-Penguin Interactions on Zoo Visitor Attitudes', *Frontiers in Psychology*, 10(2351), 1-14, available: <https://doi.org/10.3389/fpsyg.2019.02351>.
- Chiew, S.J., Butler, K.L., Sherwen, S.L., Coleman, G.J., Fanson, K.V. and Hemsworth, P.H. (2019) 'Effects of Regulating Visitor Viewing Proximity and the Intensity of Visitor Behaviour on Little Penguin (*Eudyptula minor*) Behaviour and Welfare', *Animals*, 9(6), 285-304, available: <https://doi.org/10.3390/ani9060285>.

Oral presentations

Scientific conferences

- Chiew, S.J., Sherwen, S.L., Coleman, G., and Hemsworth, P.H. (2018) 'The effects of manipulating visitor proximity and intensity of visitor interactions on little penguin behaviour and welfare.' 2018 International Congress of the International Society for Applied Ethology (ISAE), Prince Edward Island, Canada.
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- Chiew, S.J., Coleman, G., Sherwen, S.L., Melfi V., and Hemsworth, P.H. (2019) 'The behavioural response of little penguins (*Eudyptula minor*) to visitors at Taronga Zoo'. Zoo Welfare Research Symposium, Zoos Victoria, Victoria, Australia.
- Chiew, S.J., Coleman, G., Sherwen, S.L., Melfi V., and Hemsworth, P.H. (2018) 'Zoo visitor-animal interactions: effects on both the animal in display enclosures and visitors.' Zoo and Aquarium Association Conference: Animal Welfare Workshop, Wellington Zoo, Wellington, New Zealand.
- Coleman G. and Hemsworth, P.H. (2016) 'The effect of visitors on Little penguins at Taronga Zoo'. Faculty of Veterinary and Agricultural Sciences Research Symposium, University of Melbourne, Victoria, Australia.

Poster presentations

Scientific conferences

- Chiew, S.J., Sherwen, S.L., Hemsworth, P.H. and Coleman, G. (2016) 'Visitor and keeper beliefs about the effects of visitors on zoo animals.' The 50th International Society of Applied Ethology Congress, Edinburgh, Scotland / 12-15th July 2016

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Aims and Objectives

This PhD thesis aimed to determine the effects of regulating the interactions between visitors and zoo-housed little penguins (*Eudyptula minor*), on both the penguins and visitors at display enclosures. In addition, the specific objectives were:

- To determine the effects of regulating visitor-penguin interactions on little penguin behaviour and stress physiology.
- To determine how regulating visitor-penguin interactions affects visitor behaviour, attitudes, and experience.
- To determine the attitudes of visitors towards zoo-housed little penguins and the experience of visitors at the enclosure that may influence the way visitor behave towards little penguins.
- To provide advice, based on findings of this thesis, on management strategies to improve the welfare of zoo-housed little penguins and visitor experience.

Thesis outline/structure

This thesis consists of seven chapters (Figure 1). Chapter 1 is an unpublished literature review, and the remaining chapters are split into two sections: 1. The Animal - Chapters 2, 3, and 4 are published in peer-review journals; and 2. The Visitor - Chapters 5 and 6, both of which are published in a peer-reviewed journal.

Chapter 1 provides a review of the relevant literature for the current research, with a focus on the zoo visitor-animal relationship and implications on zoo animal behaviour and welfare. The examination of the effects of regulating the interactions between visitors and little penguins on little penguin behaviour and stress physiology are presented in Chapters 2, 3 and 4. Chapter 2 examines the effects of regulating visitor viewing proximity and intensity of visitor behaviour on little penguin behaviour and stress physiology at Melbourne Zoo. Chapter 3 presents the results on the effects of covering a visitor viewing area window on the behaviour of little penguins at Taronga Zoo. Chapter 4 examines the effects of visitor presence on the behaviour and stress physiology of little penguins at Wellington Zoo.

The effects of regulating the interactions between visitors and little penguins on visitor attitudes and their experience and the examination of visitor attitudes towards little penguins are presented in Chapters 5 and 6. Chapter 5 examines the effect of regulating visitor-penguin interactions on visitor attitudes and Chapter 6 presents results on the differences and similarities in visitor attitudes towards little penguins and visitor experience at two Australian zoos. Lastly, Chapter 7 discusses the main findings of this thesis, the limitations, implications, and future directions.

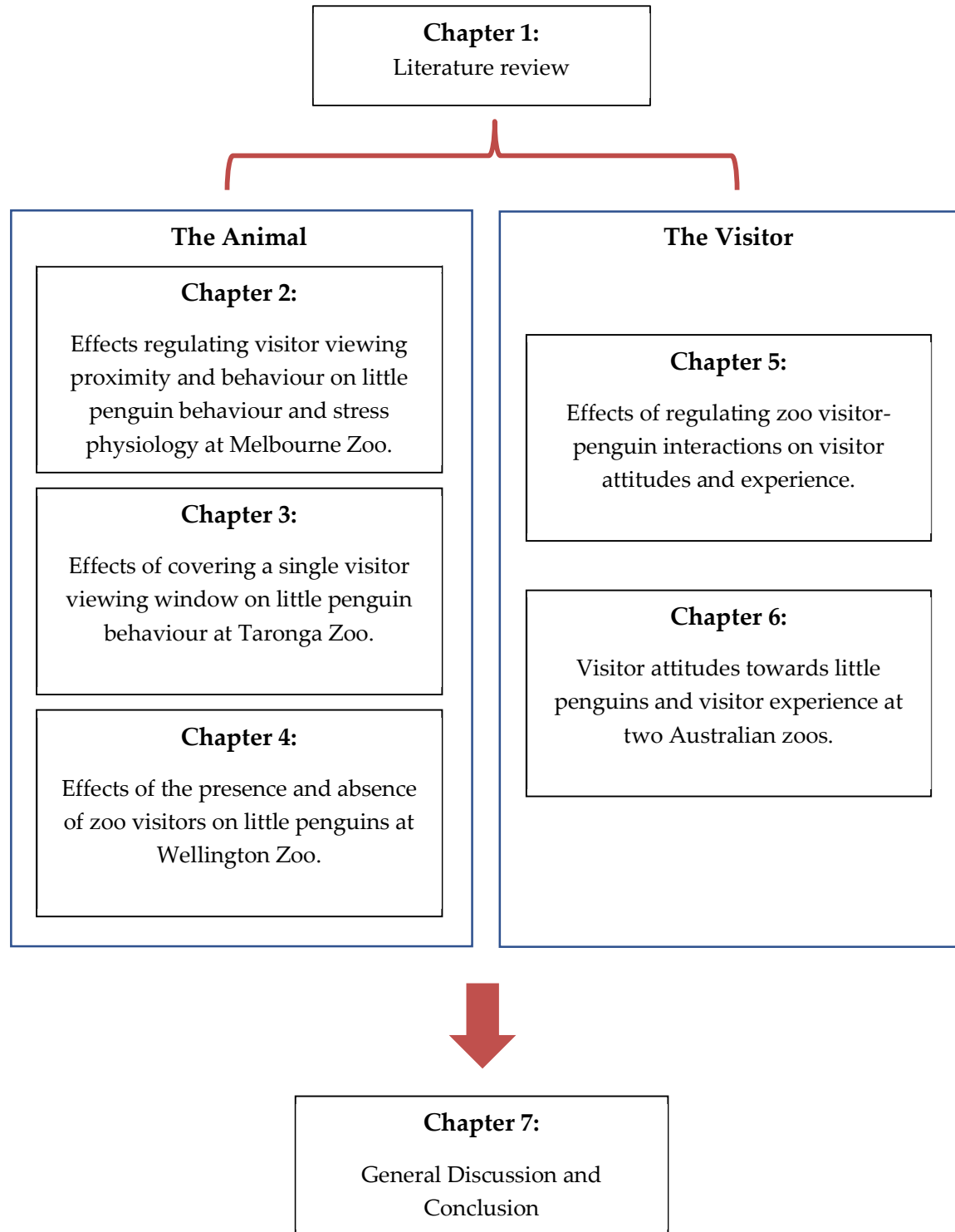
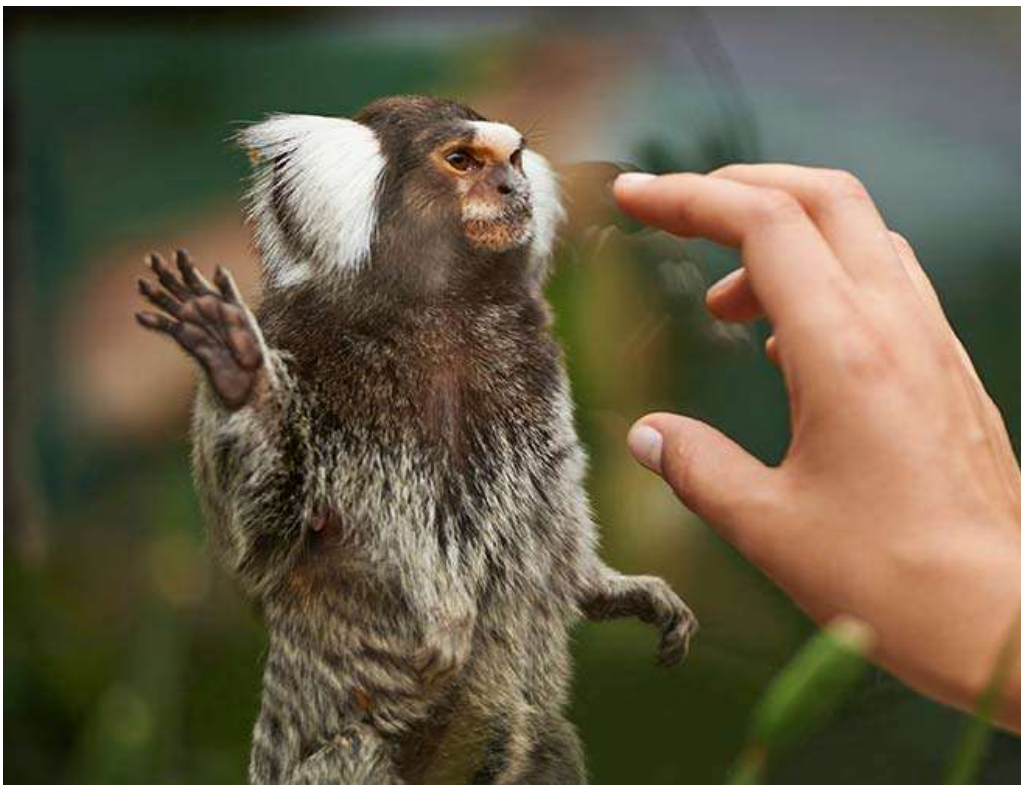


Figure 1. Thesis structure

Chapter 1

Literature review

Chapter 1 reviews the literature on the effect of visitors on zoo-housed animals, highlighting gaps in knowledge and current limitations on the zoo visitor-animal relationship. This chapter provides the foundation and rationale for the present thesis.



1.1 Introduction

Zoos have undergone some significant changes over the past several decades. These changes have been influenced by the shifts in public attitudes towards animal welfare and the worsening rate of extinction for countless wildlife (Carr and Cohen 2011; Whitham and Wielebnowski 2013; Ward *et al.* 2018). Historically, animals were placed in captivity and on display as objects of worship, religious significance or as a mark of social status (Bostock 1993; Kisling 2001; Tribe 2004). For example, the Greeks, Romans and Chinese were one of the first to established menageries, a term to describe collections of animals in captivity as a way to show their wealth and social status to others (Mazur 2001). It was not until the 18th and 19th century that the first “public zoos” or “zoological parks” were founded in Europe (Jamieson 1986; Ryder and Feistner 1995). These original zoos were primarily congenial places for social visits and human entertainment, where little thought was given to the trade-offs associated with the confinement, capture and the display of wildlife to the public (Turley 1999; Marino *et al.* 2010). However, by the 1970s, changes in public attitudes, awareness and concerns for animal welfare, the environment and conservation, influenced zoos to re-evaluate their mission and values towards conservation and not solely for the goal of entertainment (Norton *et al.* 1995; Miller *et al.* 2004; Rabb 2004; Butchart *et al.* 2010; Cole and Fraser 2018). Now in the 21st century, many modern zoos have shifted towards being zoo-based conservation organisations. As a result, underpinning modern zoos are five primary interconnected goals: 1. Conservation, 2. Education, 3. Animal welfare, 4. Research and 5. Entertainment i.e., visitor experience (Maple 2008; Fernandez *et al.* 2009; Ward *et al.* 2018; Sherwen and Hemsworth 2019). These goals form the ethical foundation of modern zoos where keeping wildlife in captivity is justified to be for the benefit of conservation and education. This is reinforced by maintaining high standards of animal welfare using evidence-based research and providing positive experiences for visitors, who are the targets of conservation and education programs (Whitham and Wielebnowski 2013; Sherwen *et al.* 2018; Godinez and Fernandez 2019).

While there is a strong ethical and justified foundation for many modern zoos, their goals can occasionally come into conflict with one another, especially when it comes to animal welfare and visitor experience (Fernandez *et al.* 2009; Sherwen *et al.* 2018; Sherwen and Hemsworth 2019). On the one hand, it is important for zoos to demonstrate and maintain high standards of animal welfare to address the public scrutiny and concerns for the quality of life of wildlife in captivity (Maple and Bloomsmith 2018; Sherwen *et al.* 2018). On the other hand, visitors are an integral part of the zoo environment and fundamental to the operation of a zoo by being a major source of funding and target of education and conservation programs (Fernandez *et*

al. 2009; Godinez and Fernandez 2019; Sherwen and Hemsworth 2019). Therefore, it is in the zoo's best interests to also provide high-quality positive experiences for visitors to maintain visitation. This often involves allowing experiences with and the viewing of wildlife up close but, there is growing evidence that visitors can affect the welfare of various zoo species (Wolfensohn *et al.* 2018; Sherwen and Hemsworth 2019). Therefore, zoos must find ways to optimise both animal welfare and visitor experience without compromising one over the other.

This review summarises and discusses the literature surrounding the welfare of zoo animals and the human-animal relationship in zoos. The initial section of the review focuses on the importance of assessing the welfare of zoo animals and the factors that influence welfare, especially visitors. The review then discusses the research to date on the effects of visitors on zoo animals, elucidates the current limitations and knowledge gaps of the visitor effect literature and the importance of understanding both sides of the zoo visitor-animal relationship.

1.2 Zoo animal welfare

In addition to the zoos' professional and ethical obligation to animals within their care, the enhancement and maintenance of high standards of zoo animal welfare is critical to the success of modern zoos (Norton *et al.* 1995; Maple and Perdue 2013). High standards of welfare for zoo animals helps improve visitor support and perceptions of zoos and their animals which ultimately supports the ex-situ and in situ conservation programs conducted by zoos (Catibog-Sinha 2008; Keulartz 2015; Ward *et al.* 2018; Wolfensohn *et al.* 2018; Godinez and Fernandez 2019; Mestanza-Ramón *et al.* 2020). Therefore, there has been a rapid increase in animal welfare related studies in zoos that can help improve current standards, regulations, management strategies and further advance applied zoo animal welfare science (Goulart *et al.* 2009; Whitham and Wielebnowski 2013; Ward *et al.* 2018). This has been greatly influenced by public pressures and increased awareness of animal welfare but also, increased knowledge of animal welfare science that has affected research and the need for better standards and legislations to govern zoo practices (Whitham and Wielebnowski 2013; Maple and Bloomsmith 2018; Hampton and Teh-White 2019; Hampton *et al.* 2020).

There has been considerable variation in the definition of animal welfare as a result of the widespread use of the term "welfare" in a range of disciplines including science, philosophy and the general community (Hemsworth and Coleman 2011; Vanhonacker *et al.* 2012). The changing societal views of what constitutes good and bad animal welfare has also made agreement for a single definition of "animal welfare" difficult (Duncan 2005; Fraser 2009; Green and Mellor 2011). It has been argued that it is impossible to have a precise definition of animal welfare because of

the ambiguity of terms such as “well-being” and “suffering” meaning different things to different people and, the difficulties of assessing and measuring welfare directly (Duncan and Dawkins 1983; Dawkins 1990; Hemsworth *et al.* 2015). However, it is generally agreed that for the welfare of an animal to be affected, the animal must be sentient (Broom 2008; Hemsworth *et al.* 2015; Broom 2016). Therefore, animal welfare is a state within the animal. Animal welfare is the physical and psychological (affective) state of an animal that relates to their experiences which arise from sensory and other neural inputs within an animal’s body and from the environment (Broom 2008; Hemsworth *et al.* 2015; Broom 2016). These inputs, once processed through the animal’s brain, represents the animal’s current experience (i.e. welfare status) and may vary on a continuum from very bad to very good (Broom 2008; Hemsworth *et al.* 2015). Therefore, “zoo animal welfare” refers to the state, physical and affective, within animals housed in zoos.

1.2.1 Measurement and assessment of zoo animal welfare

As scientific understanding of animal welfare and public concerns for the use and confinement of animals increase, animal-based industries, such as zoos must ensure that they are maintaining high standards of animal welfare. This is important for zoos to maintain their social license to operate and demonstrate their robust ethical foundation for keeping wildlife in captivity (Whitham and Wielebnowski 2013; Sherwen *et al.* 2018; Ward *et al.* 2018). A social license refers to “the process by which a community grants or withholds permission to an industry to conduct its business” (Hampton *et al.* 2020). For zoos, community acceptance is driven by their concerns for animal welfare. As a result, zoos have made some significant improvements over the past decade including advancements in zoo-based science and evidence-based research to evaluate the welfare status of zoo animals (Sherwen *et al.* 2018; Ward *et al.* 2018). These improvements have helped develop effective and reliable measures of assessment for zoo animal welfare. Having reliable and effective ways to measure and assess animal welfare ensures animals within the care of zoos experience a life worth living, to not simply survive but thrive (Green and Mellor 2011; Yeates 2011; Kagan *et al.* 2015; Mellor 2016). In particular, providing opportunities for animals to thrive within a zoo environment has been a new prime focus of many modern zoos for the continuous improvement of animal welfare (Brando and Buchanan-Smith 2018; Learmonth 2020; Miller *et al.* 2020). Opportunities to ‘thrive’ is the promotion of positive states of animal welfare and not just the removal or minimisation of negative welfare states (Mellor 2015a; Brando and Buchanan-Smith 2018; Miller *et al.* 2020). The absence of a negative welfare state does not mean an animal is in a positive welfare state. Despite this positive shift of providing zoo animals with opportunities to thrive,

there is a still need to rigorously identify and validate indicators of positive animal welfare in zoos.

There are three well established conceptual frameworks used to assess animal welfare: 'biological functioning' which is based on the premise that animals use a variety of physiological and behavioural responses to cope with changes or challenges with the environment; 'affective state' which refers to an animals affective experiences or emotions that reflect the internal biological function of an animal and how the animal perceives its environment; and lastly, 'natural living' which considers welfare to be positive if an animal is able to express natural or species-specific behaviour under natural conditions (Fraser 2009; Mellor 2012; Hemsworth *et al.* 2015). It was based on these frameworks that 'The Five Freedoms' and 'Five Provisions' were first formulated in the early 1990s (McCulloch 2013; Mellor 2016). However, as scientific understanding of the three conceptual frameworks used to assess animal welfare improved, it was recognised that 'The Five Freedoms' and 'Five Provisions' only focused on the elimination of negative animal experiences, were misinterpreted as ideals that were fully achievable and had no inclusion of the promotion of positive experiences to allow animals to thrive and not simply survive (Yeates 2011; Hemsworth *et al.* 2015; Mellor 2016). This resulted in the development of the Five Domains Model (Mellor 2015b; Mellor and Beausoleil 2015).

The Five Domains Model (Figure 1.1-1.3) was developed to provide a systematic and practical method to initially assess the welfare of animals only when compromised but now also encompasses the assessment of positive affective experiences and behavioural interactions (Mellor 2015b; Mellor and Beausoleil 2015; Mellor *et al.* 2020). This model is broken down into four physical or functional domains that include nutrition, environment, health, and behavioural interactions, and one mental domain, the animals' affective experiences (Mellor 2015b; Mellor and Beausoleil 2015; Mellor *et al.* 2020). The first three domains (Figure 1.1-1.2) primarily focus on factors related to the care of animals such as husbandry and housing (Mellor *et al.* 2020). Domain 4, "Behavioural interactions" (Figure 1.3), previously known as "Behaviour", refers to the behavioural indicators of an animal's perception of and interactions with external events and conditions including their environment, other non-human animals and humans (Mellor *et al.* 2020). This domain also highlights the flexible agency-related behaviours of animals in response to external events and conditions (Mellor *et al.* 2020). Agency-related behaviours are behaviours that animals are able to engage in that are voluntary, self-generated and/or goal-directed such as exploration, foraging, play and avoidance. Domain 5 focuses on the subjective or affective experiences of animals in terms of their welfare and provides additional details on identifying positive affective experiences that would enhance animal welfare (Mellor and Beausoleil 2015; Mellor 2017).

Recently, Sherwen *et al.* (2018) adapted the Five Domains Model for a zoo setting and demonstrated the practicality and effectiveness of this model in identifying areas of welfare risk in a wide range of species in a zoo. It utilised both animal-based and resource-based measures across the four physical/functional domains of the Five Domains Model (Whay 2007; Sherwen *et al.* 2018; Wolfensohn *et al.* 2018). Animal-based measures are indices that can be directly measured such as the animals' health and physical condition, and physiological and behavioural responses to welfare challenges such as a captive environment (Whay 2007; Whitham and Wielebnowski 2009; Koene 2013; Siegford 2013). In comparison, resource-based measures are the provision of relevant husbandry and resources such as housing, food and water which are basic essentials for animals (Whay 2007; Koene 2013; Siegford 2013; Sherwen *et al.* 2018). Therefore, animal-based measures provide a direct insight into the welfare status of the animals and how they are coping within their environment, while resource-based measures are indirect measures of welfare (Whay 2007; Whitham and Wielebnowski 2009; Koene 2013; Siegford 2013). When these indicators are integrated and used within a framework such as the Five Domains Model, it provides a powerful evidence-based approach where valuable welfare-relevant information on a wide range of species can be obtained (Melfi 2009; Mellor 2017; Sherwen *et al.* 2018). By using an evidence-based approach to assess zoo animal welfare, informed decisions based on reliable evidence can be made and thus, improve the ability of zoos to maintain high standards of animal welfare (Melfi 2009; Mellor 2017; Sherwen *et al.* 2018).

Nutritional Conditions and their Associated Affects

Negative Conditions		Positive Conditions	
<i>Nutritional inadequacies:</i>	<i>Negative affects:</i>	<i>Nutritional opportunities:</i>	<i>Positive affects:</i>
Restricted water intake	→ Thirst	Drink correct quantities of water	→ Wetting/quenching pleasures of drinking
Excessive water intake	→ Water intoxication		
	→ Hunger (general)		
Restricted food intake	→ Hunger (salt)	Eat enough food	→ Postprandial satiety
	→ Weakness of starvation		→ Pleasure of salt taste
Poor food quality	→ Malaise of malnutrition	Eat a balanced diet	→ Pleasures of food tastes/smells/textures
Low food variety	→ Eating-related boredom	Eat a variety of foods	→ Masticatory pleasures
Voluntary overeating	→ Feeling bloated or overfull	Eat correct quantities of food	→ Comfort of satiety
Force-feeding, excessive energy intake	→ Gastrointestinal pain, nausea/malaise		→ Gastrointestinal comfort

Physical Environmental Conditions and their Associated Affects

Negative Conditions		Positive Conditions	
<i>Unavoidable physical conditions:</i>	<i>Negative affects - forms of discomfort:</i>	<i>Enhanced physical conditions:</i>	<i>Positive affects - forms of comfort:</i>
Close confinement; overcrowding	→ <i>Physical:</i> general stiffness, muscle tension	Space for spontaneous locomotion	→ <i>Physical</i> comfort
Unsuitable substrate, wet/soiled ground	→ <i>Physical:</i> musculoskeletal pain, skin irritation	Suitable substrate, well-drained ground	→ <i>Physical</i> comfort
Air pollutants: NH ₃ , CO ₂ , dust, smoke	→ <i>Respiratory:</i> breathlessness, air passage irritation/pain	Fresh air dissipates contaminants	→ <i>Respiratory</i> comfort
Aversive odours	→ <i>Olfactory:</i> revulsion at foul or repellent odours	Foul smells dissipated by fresh air & good hygiene	→ <i>Olfactory</i> comfort
Thermal extremes	→ <i>Thermal:</i> chilling, dampness, overheating	Effective shelter and shade available	→ <i>Thermal</i> comfort
Loud or otherwise unpleasant noise	→ <i>Auditory:</i> impaired hearing or ear pain	Effective noise control measures are in place	→ <i>Auditory</i> comfort
Light: inappropriate intensity	→ <i>Visual:</i> eye strain due to flashing, glare or darkness	Light intensity kept at tolerable levels	→ <i>Visual</i> comfort
Monotony: ambient, physical, lighting	→ Malaise from unnatural constancy	Within-day environmental variability maintained	→ Congenial variety and predictability
Unpredictable events	→ Anxiety, fear, hypervigilance	Predictability achieved by established routines	→ Relaxation-based ease and calmness
Physical limits on rest and sleep	→ Exhaustion	Conditions conducive to rest and sleep	→ Well rested

Figure 1.1. Domain 1 and 2, Nutrition and Physical Environment respectively, of the Five Domains Model and the associated negative and positive affects assigned to Domain 5.
Obtained from Mellor *et al.* (2020).

Health Conditions and their Associated Affects

Negative Conditions		Positive Conditions	
Presence of:	Negative affects:	Minimal or no:	Positive affects:
<i>Injury:</i> acute, chronic, husbandry mutilations	➡ Pain (many types), breathlessness, debility, weakness, sickness, malaise, nausea, dizziness	Injury	➡ <i>Comfort</i> of good health and functional capacity
<i>Disease:</i> acute, chronic		Disease	➡ <i>Comfort</i> of good health and functional capacity
<i>Functional impairment:</i> due to limb amputation, other therapies; genetic, lung, heart, vascular, kidney, gut, neural, or other problems		Functional impairment	➡ <i>Comfort</i> of good health and functional capacity
<i>Obesity or leanness:</i> physical and metabolic consequences	➡ Affects of being too fat or thin, and of metabolic and pathophysiological sequelae	Extreme body condition scores	➡ <i>Comfort</i> of good health and functional capacity
Poisons	➡ Many affects due to mode of action	Poisoning	➡ <i>Comfort</i> of good health and functional capacity
Poor physical fitness, muscle de-conditioning	➡ Physical weakness and exhaustion	Poor fitness (fitness level good)	➡ Vitality of fitness and pleasurable vigorous exercise

Figure 1.2. Domain 3, Health, of the Five Domains Model and the associated negative and positive affects assigned to Domain 5. Obtained from Mellor *et al.* (2020).

Behavioural Interactions and their Associated Affects

INTERACTIONS WITH THE ENVIRONMENT			
Exercise of 'agency' is impeded:	Negative affects:	Exercise of 'agency' is promoted	Positive affects:
Invariant, barren, confined environment (ambient, physical, biotic)	→ Boredom, helplessness Depression, withdrawal	Varied, novel environment	→ Interested, pleasantly occupied
Inescapable sensory impositions	→ Various combinations: startled by unexpected events, neophobia, hypervigilance, anger, frustration, negative cognitive bias	Congenial sensory inputs	→ Likes novelty, post-inhibitory rebound
Choices markedly restricted		Available engaging choices	→ Calm, in control
Environment-focussed activity constrained		Free movement	→ Engaged by activity
Foraging drive impeded		Exploration, foraging	→ Energised, focussed
INTERACTIONS WITH OTHER ANIMALS			
Animal-to-animal interactive activity constrained	→ Loneliness, depression Yearning for company	Bonding/reaffirming bonds	→ Affectionate sociability
	→ Thwarted desire to play	Rearing young	→ Maternal, paternal or group rewards
	→ Sexual frustration	Playing	→ Excitation/playfulness
	→ Thwarted hunting drive	Sexual activity	→ Sexually gratified
Significant threats	→ Anger, anxiety, fear, panic, insecurity, neophobia	Hunting	→ Alert engagement, highly stimulated
Limits on threat avoidance, escape or defensive activity		Absence of threats	→ Secure, protected, confident
Limitations on sleep/rest	→ Exhaustion	Using refuges, retreat or defensive attack	
		Sleep/rest sufficient	→ Energised, refreshed; post-inhibitory rebound
INTERACTIONS WITH HUMANS			
Negative human attributes and behaviour:	Animal behaviours and negative affects:	Positive human attributes and behaviour:	Animal behaviours and positive affects:
Attitude: uncertain, fearful, indifferent, insensitive, impatient, oppressive, belligerent, domineering, callous, cruel, vindictive	→ Behaviours (e.g.): long flight distance, hypervigilant, attack/fight, hyper-reactive, escape avoidance, freezing, cowering, appeasing, withdrawn, non-compliant	Attitude: confident, caring, sensitive, patient, kind, empathetic	→ Behaviours: short flight distance, calm alertness, at ease with imposed hands-off or hands-on contact, compliantly responsive, explores novel events, seeks contact, variably bonded with humans
Voice: hesitant, angry, loud, shouting		Voice: confident, calm, clear, encouraging, pleasantly rhythmic	
Aptitude: inexperienced, unskilled, untrained, unqualified		Aptitude: experienced, skilled, trained, qualified	
Handling/controlling: erratic, rough (slap, hit, kick, grab, poke, beat, whip); excessively forceful, violent; punishment-focussed; more negative pressure than is needed for training objective	→ Affects: anxiety, fear, panic, terror, neophobia; insecurity, confusion, uncertainty, persistent unease; helplessness; pain from injuries; negative cognitive bias	Handling/controlling: skillful, gentle (stroke, touch, push, guide); firm, temperate, restrained; reward-focussed; mimics allo-grooming by conspecifics; using subtle pressure cues, secondary reinforcers and timely release of aversive stimuli	→ Affects: calm, confident, at ease, feels in control; enjoys variety; finds being bonded with humans rewarding

Figure 1.3. Domain 4, Behavioural Interactions, of the Five Domains Model and the associated negative and positive affects assigned to Domain 5. Obtained from Mellor *et al.* (2020).

1.2.2 Factors that influence zoo animal welfare

There are several factors of the zoo environment that can influence the welfare of zoo animals indicated by changes in the behavioural and physiological responses of animals (Sherwen *et al.* 2018). For example, the physical (i.e., enclosure design) and social environment, provision of enrichment and human presence are factors that affect zoo animal welfare (Whitham and Wielebnowski 2013; Hosey 2014; Sherwen *et al.* 2018; Ward and Sherwen 2018). These factors may be a source of potential stress to animals as a result of a lack of choice and control or if stressors are not well managed (Morgan and Tromborg 2007; Mason 2010). Therefore, managing factors that can be a potential source of stress for zoo animals is important to ensure that negative impacts on animal welfare can be effectively minimised and prevented.

Historically, zoo enclosures used to be barren cages that isolated and restricted the movements of animals as a result of zoos at that time, were just places of entertainment and recreation (Shettel-Neuber 1988; Kirkwood 2003; Tribe 2004). However, as public perceptions and attitudes changed and understanding of animal welfare increased, zoos shifted their focus towards environmental and species conservation and education. This resulted in zoo enclosure designs significantly changing. Studies show that enclosure design elements such as the size or space allowance in an enclosure, access to indoor or outdoor areas, type of substrates provided within the enclosure, the social environment and whether the enclosure is naturalistic, can influence the behaviour and physiology of various zoo species (Ross *et al.* 2009; Descovich *et al.* 2012; Fabregas *et al.* 2012; Fanson and Wielebnowski 2013; Mun *et al.* 2013; Lewis *et al.* 2017; Miller *et al.* 2018). For example, increased space allowance was found to increase foraging and reduce agonistic interactions with conspecifics in southern hairy nosed wombats (*Lasiorninus latifrons*) and reduced faecal glucocorticoid metabolite concentrations in Canadian lynxes (*Lynx canadensis*) (Descovich *et al.* 2012; Fanson and Wielebnowski 2013). Furthermore, naturalistic enclosures have been shown to promote species-specific behaviours and behavioural diversity (Mallapur and Chellam 2002; Mun *et al.* 2013; Bryan *et al.* 2017; Spain *et al.* 2020). Naturalistic enclosures attempt to replicate the habitat of species found in the wild but may not always be aesthetically naturalistic or necessarily promote species-specific behaviours in all zoo-housed species (Melfi *et al.* 2004; Fabregas *et al.* 2012; Lukas and Ross 2014). If enclosures are not designed well, this can result in negative effects on zoo animal welfare and visitor education and experience (Coe 1985; Coe 1987; Coe 1989; Morgan and Tromborg 2007; Miller *et al.* 2018). Thus, modern zoo enclosure design must take into consideration the ecology of the animal, natural life history, the different design elements of an enclosure and understand the effects of enclosure design on the welfare of zoo animals.

Studies show that an animal's social environment, such as group size, can also have profound effects on zoo animal welfare, particularly if the size of the groups are inappropriate for the species (Price and Stoinski 2007). For example, zoo-housed duikers (*Cephalophinae*) when housed in groups of more than five, increased the incidence of stress-related jaw abscesses (Barnes *et al.* 2002). Canadian lynxes (*Lynx canadensis*) increased adrenocortical activity when housed in groups rather than individually (Fanson and Wielebnowski 2013). Housing social species such as monkeys in isolation from conspecifics can result in increased levels of stereotypic behaviour and chronic stress (Price and Stoinski 2007). Similarly, when small felid species are housed in groups greater than a pair, the likelihood of reproduction reduces (Mellen 1991). Therefore, the design of the enclosure, management and husbandry of each species are important to consider when managing the effect of an animal's social environment on animal welfare.

Environmental enrichment is another factor that can influence zoo animal welfare and is often part of routine husbandry. Environmental enrichment such as climbing structures, scatter feeds, concealed food and novel objects, can encourage species-specific behaviours and behavioural diversity and decrease behaviours indicative of stress such as stereotypic behaviour (Hunter *et al.* 2002; Bashaw *et al.* 2003; Rosier and Langkilde 2011; Watters *et al.* 2011; Clark and Melfi 2012; Burghardt 2013; Damasceno *et al.* 2017; de Almeida *et al.* 2018; Fernandez *et al.* 2019; Regaiolli *et al.* 2019; Riggio *et al.* 2019). Furthermore, provision of environmental enrichment has positive impacts on visitors and should be an integral part of zoo exhibit design. For example, research has shown that when animals are observed interacting with enrichment items, visitor interest increases and can improve visitor perceptions of zoo animals (Altman 1998; Davey *et al.* 2005; Coe 2017; Riggio *et al.* 2019)

Other factors like the sensory environment, climate, predictability of husbandry routine, rearing history and genetics can also affect the welfare of zoo animals (Mason 2010; Mason *et al.* 2013; Ward and Sherwen 2018; Binding *et al.* 2020). But one the most influencing features of the zoo environment on animal welfare are the presence of humans. Keepers, other zoo staff and visitors can have major effects on the welfare of zoo animals. There is a growing body of evidence demonstrating that humans, whether they be familiar (keepers) or unfamiliar (visitors), can influence the behaviour and physiology of a range of zoo species (Carlstead 2009; Fernandez *et al.* 2009; Whitham and Wielebnowski 2009; Ward and Melfi 2015; Cole and Fraser 2018; Sherwen and Hemsworth 2019). Therefore, understanding the human-animal relationship in zoos has never been more paramount.

1.3 The human-animal relationship in zoos

A human-animal relationship is formed as a result of the history of interactions between animals and humans whereby each individual partner's experience of the relationship allows it to learn and anticipate future interactions and thus, behave accordingly (Hemsworth and Coleman 2011). Our understanding of the human-animal relationship has derived from the extensive research in agriculture where it is well established that humans are major determinants of animal welfare (Hemsworth and Coleman 2011). Studies have shown that the interactions between livestock and the stockpeople who handle and manage them, can have a substantial effect on the behaviour, physiology and productivity of farm animals (Hemsworth and Coleman 2011). For example, stockpeople that engaged in negative handling such as slaps, hits or prods using a goad towards farm animals, increased levels of fear of humans and stress in animals which subsequently resulted in reductions in productivity (Hemsworth *et al.* 1994; Hemsworth 2003; Hemsworth and Coleman 2011). Furthermore, there is evidence that the nature of the interactions between farm animals and stockpeople is influenced by a stockperson's attitude towards animals, their beliefs about other people's expectations of them as a stockperson, and their beliefs about the extent to which they have control over their ability to appropriately interact with animals (Hemsworth *et al.* 1994; Coleman *et al.* 2000; Hanna *et al.* 2009). This results in the formation of a sequential relationship between the attitudes and behaviour of humans and animal behaviour and welfare (Hemsworth and Coleman 2011). By understanding this relationship (Figure 1.4), the negative effects of humans on animals, such as fear and stress, can be minimised. This can be achieved by targeting human attitudes to modify their behaviour towards animals and thus, improve the management of human-animal interactions (Hemsworth *et al.* 1994; Coleman *et al.* 2003; Hemsworth 2003; Ellingsen *et al.* 2014). Similar models have been proposed for a zoo setting by Hosey (2013) and recently presented by Ward and Sherwen (2018). But, in comparison to the extensive research in agriculture, comprehensive understanding of the human-animal relationship in zoos remains limited.

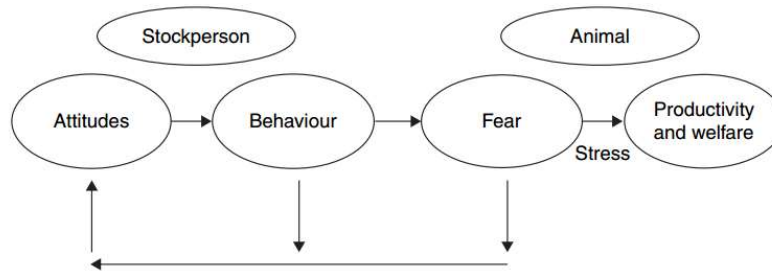


Figure 1.4. The Hemsworth-Coleman model. Obtained from Hemsworth and Coleman (2011).

For zoos, understanding the human-animal relationship is important because humans are an integral part of the zoo environment, whether that be the keepers or visitors that zoo animals encounter on a daily basis. In particular, the interactions between zoo animals and visitors may be frequent but unpredictable and sometimes intense (Hosey 2013; Ward and Melfi 2015; Cole and Fraser 2018; Sherwen and Hemsworth 2019). Research shows that keepers and their routine husbandry, such as cleaning and feeding, that occur at consistent times and used with a reliable signal (e.g. knocks on the door or doorbell before entering enclosure), can reduce stress and anxiety-related behaviours such as self-scratching, vigilance and pacing and anticipatory behaviour in brown capuchin monkeys (*Sapajus apella*), rhesus macaques (*Macaca mulatta*) and African elephants (*Loxodonta africana*) (Koyama *et al.* 2012; Gottlieb *et al.* 2013; Rimpley and Buchanan-Smith 2013). Also, positive reinforcement training when integrated into husbandry routines can reduce stereotypic behaviours in various species such as African wild dogs (*Lycaon pictus*), rhesus macaques and polar bears (*Ursus maritimus*), reduce agonistic behaviours in ring-tailed lemurs (*Lemur catta*) and reduce physiological stress such as salivary cortisol in wolves (*Canis lupus*) (Coleman and Maier 2010; Shyne and Block 2010; Gottlieb *et al.* 2013; Shepherdson *et al.* 2013; Vasconcellos *et al.* 2016; Spiezio *et al.* 2017). In comparison, felids have been found to reduce resting behaviour and increase anticipatory and stereotypic behaviours (indicators of restlessness and stress) in response to predictable routine husbandry (Mallapur and Chellam 2002; Quirke *et al.* 2012; Hottges *et al.* 2019). This suggests that some level of unpredictability in the location and timing of food delivery is important for some zoo species as a possible form of stimulation and enrichment (Kistler *et al.* 2009; Rees 2009; Watters *et al.* 2011; Schneider *et al.* 2014). Furthermore, positive interactions between keepers and zoo animals have been shown to positively affect animal welfare such as reduced stress and abnormal behaviours and increased reproductive success and affiliative behaviours (Mellen 1991; Baker 2004; Manciocco *et al.* 2009; Ward and Melfi 2015; Cole and Fraser 2018; Ward and Sherwen 2018; Carlstead *et al.* 2019). Thus, these interactions can promote a positive keeper-animal relationship. However, the study of the zookeeper-animal relationship remains

limited (Hemsworth *et al.* 2018; Ward and Sherwen 2018; Patel *et al.* 2019). Nevertheless, it is evident that zookeepers can have significant effects on zoo animal welfare.

The effect of visitors on zoo animals has received considerably more attention than the keeper-animal relationship (Sherwen and Hemsworth 2019). This may be because modern zoos are increasingly interested in providing visitors with close-up experiences and interactions with animals to enhance visitor experience and increase conservation awareness (Woods 2002; Ballantyne *et al.* 2007; Clayton *et al.* 2009; Howell *et al.* 2019). However, it is evident that this can have implications for the welfare of zoo animals (Fernandez *et al.* 2009; Sherwen and Hemsworth 2019). The effect of visitors on the behaviour and welfare of zoo animals is the focus of this thesis.

1.3.1 The effect of visitors on zoo animals

The zoo visitor-animal relationship is the history of interactions between a zoo animal and visitor where each individual's perception of the interactions and thus, the relationship, allows them to interpret and predict future interactions with one another (Hinde 1976; Hosey 2013; Hemsworth *et al.* 2018). The provision of high quality visitor experiences is important to help increase public support for zoos since visitors are an integral part of the zoo environment and major source of funding (Sherwen and Hemsworth 2019). Thus, modern zoos are increasingly interested in finding ways to connect visitors with wildlife to promote positive visitor experiences and increase conservation awareness. This has been achieved by immersing visitors in a learning environment, filled with interactive exhibits, interpretive tours, educational programs, and unique close-up interactions that bring visitors face-to-face with wildlife (Woods 2002; Anderson *et al.* 2003; Nakamichi 2007; Jones *et al.* 2016; Orban *et al.* 2016). In particular, close-up interactions may involve visitors entering an enclosure to pat or feed animals (close-up encounters) or designing enclosures to allow visitors to easily view animals on display in close proximity (Woods 2002; Myers *et al.* 2004; Hosey 2005; Clayton *et al.* 2009; Fernandez *et al.* 2009; Luebke 2018; Saiyed *et al.* 2019; Ramont *et al.* 2021). Close-up encounters and viewing animals that are active in close viewing proximity have been found to promote positive emotional experiences for visitors and increase reports of conservation mindedness (Myers *et al.* 2004; Powell and Bullock 2014). However, despite these experiences being beneficial for visitors, they expose zoo animals to the presence and close proximity of visitors for long periods of time.

Growing research has shown that zoo visitors can be a source of fear and stress for many zoo species as a result of the unpredictability and sometimes intensity of close visitor contact (Sherwen and Hemsworth 2019). This is concerning not only in terms

of animal welfare but also visitor experience as visitors care about the welfare of zoo animals and signs of animal suffering, fear and stress is detrimental to the success and social licensing of modern zoos (Melfi *et al.* 2004; Clayton *et al.* 2009; Skibins and Powell 2013; Sherwen and Hemsworth 2019). Therefore, there is an inextricable relationship between animal welfare and visitor experience. This has resulted in an important area of research to help zoos improve their understanding of the visitor-animal relationship and better manage visitor-animal interactions.

Over the past several decades, research on the effect of visitors on zoo animals, also known in the literature as visitor effects, has steadily increased. This area of research has shown mixed findings where visitors have been found to be stressful or fear-provoking (negative), enriching or stimulating (positive) and innocuous (neutral) for different zoo species (Hosey 2000; Hosey 2013; Sherwen and Hemsworth 2019). The following sections highlights some of the main findings of the visitor effect literature and Table 1.1 presents a list of the growing extensive literature in this area.

1.3.1.1 Negative effects

Studies to date show that the effects of visitors have been primarily negative in which visitors have been interpreted as fear-provoking and stressful for these animals. This has been based on widely documented behavioural indicators such as avoidance (fleeing or retreating), inhibition of movement (freezing), aggression, vigilance and stereotypies; and physiological indicators such as glucocorticoid concentrations in blood, faeces, urine and saliva (Hemsworth *et al.* 2018; Sherwen and Hemsworth 2019). These behaviour and physiological measurements are validated indicators of increased fear and stress in animals. Several studies have found that the presence of visitors, reduced the visibility of quokkas (*Setonix brachyurus*), increased avoidance of the visitor viewing area, huddling and aggression in little penguins (*Eudyptula minor*) and decreased activity and increased use of hidden spaces away from visitors in various felid species (Mallapur and Chellam 2002; Sherwen *et al.* 2015c; Suárez *et al.* 2017; Learmonth *et al.* 2018). Other studies have shown decreased affiliative behaviours in Cotton-top tamarins (*Saguinus Oedipus*), Diana monkeys (*Cercopithecus diana*) and ring-tailed lemurs (*Lemur cutta*); increased stereotypic behaviours such as pacing or running in jaguars (*Panthera onca*), Indian leopards (*Panthera pardus fusca*) and Fennec foxes (*Fennecus zerda*); and increased rates of aggression in various primate species as visitor numbers increased (Glatston *et al.* 1984; Chamove *et al.* 1988; Carlstead 1991; Mitchell *et al.* 1991; Sellinger and Ha 2005; Wells 2005; Todd *et al.* 2007; Vidal *et al.* 2016; Vaz *et al.* 2017). Also, more specific aspects of visitor contact have been shown to negatively affect certain species. For example, intra-group aggression and stereotypic or abnormal behaviours, such as repetitive teeth clenching, body rocking, pacing and self-scratching, increased in Western lowland gorillas (*Gorilla*

gorilla) and black-capped capuchins (*Sapajus apella*) when contact with visitors was not visually obscured (Blaney and Wells 2004; Sherwen *et al.* 2015b). This indicates that visual contact with visitors specifically affects these species negatively likely because of the facial expressions and visual gestures of humans being perceived as threatening (Blaney and Wells 2004; Sherwen *et al.* 2015b).

Changes in stress physiology as a result of negative visitor effects has also been evident. Higher faecal glucocorticoid concentrations in Mexican wolves (*Canis lupus baileyi*), Bornean orangutans (*Pongo pygmaeus*), meerkats (*Suricata suricatta*) and capuchins have been found in response to increased visitor numbers and visual contact with visitors (Pifarré *et al.* 2012; Amrein *et al.* 2014; Sherwen *et al.* 2015b; Katy Scott *et al.* 2017). Other studies have found increased noise level and visitor numbers increase urinary glucocorticoid concentrations in giant pandas (*Ailuropoda melanoleuca*) and spider monkeys (*Ateles geoffroyii rufiventris*) (Owen *et al.* 2004; Davis *et al.* 2005). Similarly, greater salivary cortisol in Asian elephants (*Elephas maximus*) and Indian rhinoceros (*Rhinoceros unicornis*) has been observed in the presence of visitors compared to their absence (Menargues *et al.* 2008). Increases in faecal, urinary, and salivary glucocorticoids are indicators of increased stress in animals and thus, a negative effect of visitors.

These changes in both animal behaviour and stress physiology demonstrate the negative effects visitors can have on the welfare of zoo animals which is a concern for zoos. If these negative effects are not addressed in the long term, zoo animals may experience acute and chronic stress from exposure to visitors as well as reductions in visitor experience and subsequent visitor support for zoos. These implications make understanding the visitor-animal relationship critical for zoos to mitigate and manage these risks to both the animals and visitors.

1.3.1.2 Positive effects

Despite many studies showing negative visitor effects on animal behaviour and stress physiology, there is growing evidence that visitors can be a form of enrichment or stimulation and thus, have positive effects on some zoo species. Firstly, enrichment is broadly considered as the addition of stimuli or provision of choices that encourage species-specific behaviours and behavioural diversity and decrease behaviours indicative of stress such as stereotypic behaviour (Carlstead and Shepherdson 1994; Shepherdson 1998; de Azevedo *et al.* 2007). Secondly, it encapsulates changes to an animal's environment that result in positive impacts which can result from keepers, visitors, or other elements of their surrounding environment (Hoy *et al.* 2010; Mills *et al.* 2010; Mehrkam and Dorey 2014; Mehrkam *et al.* 2014). Therefore, positive effects of visitors on zoo animals are generally characterised by behaviours that suggest

reduced stress or fear and increased comfort and confidence with visitors. This may include reductions in avoidance and abnormal behaviours and increases in affiliative behaviours, attention seeking behaviours and initiated interactions with visitors (Ward and Sherwen 2018; Sherwen and Hemsworth 2019).

Some of the studies have found that when there were fewer visitors present, a long-billed Corella (*Cacatua tenuirostris*) increased time spent interacting with visitors (Nimon and Dalziel 1992). Squirrel monkeys (*Saimiri sciureus*) increased time spent in close proximity to visitors when large groups of visitors were present compared to small groups or no visitors (Polgar *et al.* 2017). Humboldt (*Spheniscus humboldti*) and Gentoo (*Pygoscelis papua*) penguins have also been found to be positively affected by visitors indicated by an increase in submerged swimming and increase in behavioural diversity and pool use, respectively (Condon *et al.* 2003; Collins *et al.* 2016). Furthermore, high visitor numbers have been found to increase play behaviour in Diana monkeys and increase time spent resting and allogrooming and movement closer to visitors and decrease time spent vigilant in Black-tailed prairie dogs (*Cynomys ludovicianus*) (Nimon and Dalziel 1992; Todd *et al.* 2007; Eltorai and Sussman 2010). Behaviours such as play and allogrooming are suggested to be indicators of positive welfare as they commonly occur when animals are relaxed (Boissy *et al.* 2007).

Visitors have been suggested to have positive effects on zoo animals particularly when they are associated with food. For example, green monkeys (*Chlorocebus sabaeus*), chimpanzees (*Pan troglodytes*), ring-tailed, ruffed (*Varecia variegata*) and crowned (*Eulemur coronatus*) lemurs and European red squirrels (*Sciurus vulgaris*) increase time spent in close proximity of and interacting with visitors to solicit food from visitors suggesting enrichment from visitors (Fa 1989; Cook and Hosey 1995; Manna *et al.* 2007; Jones *et al.* 2016; Woolway and Goodenough 2017). This is suggested to be a positive visitor effect because animals obtained a food reward and learnt to associate visitors with something positive. Similarly, there has been some suggestion of reduced oral stereotypic behaviour such as object-licking and tongue-rolling in giraffes (*Giraffa camelopardalis*) as result of visitor feeding programs but only when time spent eating routine diets was also taken into account (Orban *et al.* 2016). Interestingly, Bloomfield *et al.* (2015) showed orangutans have a preference to position themselves facing the visitor viewing area. This suggests that visitors themselves or the visitor viewing area may be enriching since visitors alter the viewing area frequently which may be visually stimulating for orangutans. More recently, zoo-housed servals (*Leptailurus serval*) were found to reduce stereotypic pacing on weeks when participating in interactive presentations that attracted high visitor numbers, or when combined with behind-the-scenes encounters with visitors (Acaralp-Rehnberg *et al.* 2020). Despite this

increasing evidence of positive visitor effects, these effects are still sparse and requires further investigation in more zoo-housed species.

1.3.1.3 Neutral effects

In addition to visitors being evidently negative and positive for various species, some studies show that visitors have no effect (i.e., neutral) on zoo animals. Neutral visitor effects have been indicated by a lack of change in animal behaviour or physiology in response to visitor contact and suggests may habituate to visitors (Hosey and Melfi 2015; Sherwen and Hemsworth 2019). Neutral effects of visitors are when visitors are interpreted or perceived by animals as an inanimate or a non-threatening part of their environment (Hosey 2008; Sherwen and Hemsworth 2019). For example, some studies show that visitor presence or absence has no effect on the activity patterns or the spatial location within the enclosure of some felids such as cheetahs (*Acinonyx jubatus*), lions (*Panthera leo*) and leopards (O'Donovan *et al.* 1993; Margulis *et al.* 2003). Similarly, greater rheas (*Rhea americana*) and lesser anteaters (*Tamandua tetradactyla*) have been found to show minimal to no behavioural change in the presence or absence of visitors (de Azevedo *et al.* 2012; Chiapero *et al.* 2020). When visitor behaviour was regulated or unregulated, meerkat behaviour including location in the enclosure and the time spent vigilant did not change which suggests visitors were inconsequential (Sherwen *et al.* 2014). Furthermore, Kangaroo Island (*Macropus fuliginosus*) and Red kangaroos (*Macropus rufus*) increased vigilance and Kangaroo Island kangaroos increased time spent locomoting and reduced resting when visitor number increased (Sherwen *et al.* 2015a). However, no change was found in the distance the kangaroos positioned themselves from the visitor pathway or in faecal glucocorticoid metabolites when visitor numbers increased (Sherwen *et al.* 2015a). This suggests that overall, visitors did not have an adverse effect and rather neutral effect on these kangaroos. Other zoo-housed species that showed no change in stress physiology as a result of visitor contact have included koalas (*Phascolarctos cinereus*) and African penguins (*Spheniscus demersus*) (Narayan *et al.* 2013; Ozella *et al.* 2017). Although there is growing evidence of neutral effects of visitors, such evidence is still limited. This may be because most studies have focused on identifying negative effects of visitors and have been primarily restricted to certain taxa such as mammals (Sherwen and Hemsworth 2019). Consequently, neutral effects of visitors may be more widespread than what is currently known.

Table 1.1. A summary of published peer reviewed studies conducted on the effects of visitors on zoo animals, indicating the visitor and animal variables examined, key findings and suggested visitor effect. Studies are categorised into taxa and listed in chronological order.

Species	Visitor Variables	Animal Variables	Key findings	Suggested visitor effect	Reference
<i>Non-human primates</i>					
Cotton-top tamarins	Number, presence vs. absence	Behaviour	When on-display to the public compared to off-display, social behaviour and play decreased and agonistic interactions increased. Amicable behaviours (e.g., allogrooming, play, nest box share) between tamarin breeding pairs were negatively correlated with visitor number. Agonistic encounters between mother and young were positively correlated with visitor number.	Negative	(Glatston <i>et al.</i> 1984)
Cotton-top tamarins, Diana monkeys, lemurs	Presence vs. absence and number	Behaviour	In the presence of visitors, aggression and activity increased and affiliative behaviours decreased. As visitor numbers increased, attention to visitors, activity and stereotypic behaviour increased.	Negative	(Chamove <i>et al.</i> 1988)
Green monkeys	Presence vs. absence	Behaviour	No difference in agonistic behaviours between days when visitors were present and absent. When visitors were present, animals increased food-directed behaviours, activity, and dispersion in the enclosure to take advantage of food thrown in by visitors.	Positive	(Fa 1989)
Golden bellied mangabeys	Number	Behaviour	When animals were moved to cages exposed to more visitors, aggressive displays toward people increased,	Negative	(Mitchell <i>et al.</i> 1991)

Species	Visitor Variables	Animal Variables	Key findings	Suggested visitor effect	Reference
			aggressive displays toward other species in neighbouring cages decreased, and within-group aggression increased.		
Barbary macaques	Visitor feeding	Behaviour	The number of people bitten increased in the afternoon which was the main visitation time. More bites were recorded during summer months when visitor numbers were higher. A negative correlation was found between visitor age and the likelihood of being bitten.	Negative	(Fa 1992)
Siamangs	Number	Behaviour	Siamang behaviour did not change in relation to visitor number. But siamangs appeared to respond to some human behaviours (hostile mimicry) as they would to hostile behaviours from conspecifics.	Neutral	(Nimon and Dalziel 1992)
Golden-bellied mangabeys	Number	Behaviour	When a one group of mangabeys were moved from a location having many visitors to a location with few visitors, the frequency of mangabey facial threats toward people and threats within the mangabey group decreased and threats toward primates in neighbouring cages increased. When a second group was moved from the location of low visitation to a location of high visitation, attention towards visitors and primates within the cage increased and attention to neighbouring captive primates decreased.	Negative	(Mitchell <i>et al.</i> 1992a)
Ring-tailed, goose and red-ruffed lemur, squirrel monkey, Francois langur,	Group size and activity	Behaviour	Locomotory activity increased when both small and large active audiences were present compared to when no audience was present. Primates were frequently observed at	Unclear	(Mitchell <i>et al.</i> 1992b)

Species	Visitor Variables	Animal Variables	Key findings	Suggested visitor effect	Reference
spot-nosed monkey, De Brazza's monkey, golden-bellied mangabey, gibbon, orang-utan, chimpanzee			the front of the enclosure when active audiences were present compared to passive audiences.		
Chimpanzees	Interaction sequences	Behaviour	Chimpanzees regularly initiated interactions with visitors and primarily interacted with visitors to obtain food.	Positive	(Cook and Hosey 1995)
Orangutans	Number and noise	Behaviour	During periods of high visitation, adult orangutans increased their use of paper sacks to cover their heads and increased clutching behaviour by infants onto adults. Noisy visitor groups increased orientation towards visitors and clutching behaviour to adults by infants.	Negative	(Birke 2002)
Western lowland gorillas	Visual contact vs. no visual contact	Behaviour	Visual contact with visitors increased gorilla intra-group aggression and abnormal behaviours including repetitive teeth clenching and body rocking . When the camouflage net barrier was placed on the viewing area of the exhibit, aggression and stereotypic behaviours decreased.	Negative	(Blaney and Wells 2004)
Lion-tailed macaques	Presence vs. absence	Behaviour	On days when visitors were present compared to days when they were absent, the frequency of abnormal behaviour such as begging, self-biting and bouncing increased and social behaviour and visibility decreased.	Negative	(Mallapur <i>et al.</i> 2005)
Western lowland gorillas	Number	Behaviour	Low visitor numbers increased behaviours suggestive of relaxation such as time spent resting. High visitor numbers	Negative	(Wells 2005)

Species	Visitor Variables	Animal Variables	Key findings	Suggested visitor effect	Reference
			increased intragroup aggression, stereotypies, and auto-grooming.		
Spider monkeys	Number	Urinary cortisol	Increased urinary cortisol was positively associated with increased visitor numbers.	Negative	(Davis <i>et al.</i> 2005)
Diana monkeys	Number	Behaviour	As visitor numbers increased, time spent grooming and sleeping/resting decreased and time spent playing and feeding/chewing increased.	Negative	(Todd <i>et al.</i> 2007)
White handed gibbons	Number and noise	Behaviour	When visitor numbers and noise levels increased, looking at the public by all four gibbons increased. Higher noise levels increased self-scratching behaviour in two individuals.	Negative	(Cooke and Schillaci 2007)
Ring-tailed lemurs	Presence vs. absence	Behaviour	When visitors were present within the enclosure, lemurs increased their activity, increased close contact with visitors and terrestrial locomotion to interact with and receive food from visitors.	Positive	(Manna <i>et al.</i> 2007)
Western lowland gorillas	Number	Behaviour	At Chessington Zoo, durations of self-scratching and visual monitoring were unrelated to visitor number, irrespective of periods of enrichment. At Port Lympne Zoo, durations of both self-scratching and visual monitoring were positively associated with visitor number when no feeding enrichment occurred. No relationships were found between visitor number and	Neutral at Chessington Zoo Negative at Port Lympne Zoo if	(Carder and Semple 2008)

Species	Visitor Variables	Animal Variables	Key findings	Suggested visitor effect	Reference
			anxious behaviours by gorillas during periods of feeding enrichment.	no enrichment given	
Western lowland gorillas	Number	Behaviour	Gorillas were less visible during the days with large crowds compared to days with small crowds. The bachelor group of gorillas were more aggressive during the days with large crowds compared to days with small crowds. The family group of gorillas that showed no increase in aggression on large crowd days.	Negative	(Kuhar 2008)
Siamangs and White-cheeked gibbons	Number	Behaviour	No difference was found between the species in their behavioural response to visitor number. Both species spent more time in areas away from public (i.e., in treetops, tunnels or on the back of the temples) on high visitor number days compared to low visitor number days.	Negative	(Smith and Kuhar 2010)
Orangutans	Number, proximity, and behaviour	Behaviour	Visitor number had little effect on the orang-utans, except at one of the exhibits where the likelihood of food soliciting and looking at visitors increased when the number of people numbered more than 40. Visitor activity was not associated with any obvious signs of stress in the orangutans. Visitors taking photographs or holding food increased begging and orientation to visitors. Visitors at close proximity decreased play behaviour and increased looking at the visitors by the animals which suggests visitors may be as source of some stress for orangutans.	Neutral	(Choo <i>et al.</i> 2011)

Species	Visitor Variables	Animal Variables	Key findings	Suggested visitor effect	Reference
Hamadryas baboons	Presence vs. absence	Behaviour	On days with more visitors compared to days with no visitors, the dominant male baboon increased the throwing of faeces towards visitors or zoo staff.	Negative	(Bortolini and Bicca-Marques 2011)
Pileated gibbons	Visual contact vs. no visual contact	Faecal glucocorticoid metabolite (FGM) concentrations	Gibbons that had visual protection from visitors had lower FGM concentrations than those without visual protection. Gibbons with no visual protection from visitors had higher FGM concentrations than those that could hide out of sight.	Negative	(Pirovino <i>et al.</i> 2011)
Western lowland gorillas	Number	Behaviour	Two groups of gorillas spent more time engaged in stereotypic behaviour as visitor number increased. The other two groups showed the opposite response pattern. Males showed higher rates of aggression with higher visitor number.	Negative	(Stoinski <i>et al.</i> 2012)
Western lowland gorillas	Number and noise	Behaviour and FGM	When there were more visitors and higher noise levels, gorillas increased staring, posturing, and charging at visitors and decreased food-related behaviour. No effect was found on FGM concentrations. Privacy screens were found to reduce staring, posturing, and charging at visitors.	Negative	(Clark <i>et al.</i> 2012)
Cotton-top tamarin, white-faced saki, orangutan	Proximity, number, and behaviour	Behaviour	The cotton-top tamarins had the highest visibility, closest proximity to visitors, highest interaction levels, and attracted the largest crowds (followed by the orangutans and white-faced sakis). The tamarins had the highest	Negative	(Mun <i>et al.</i> 2013)

Species	Visitor Variables	Animal Variables	Key findings	Suggested visitor effect	Reference
			number of undesirable interactions with visitors (e.g., bit, scratched, facial or vocal threat at visitors, lunged or chased visitors).		
Bornean orangutans	Number	Behaviour and FGM	As visitor number increased, FGM concentrations increased and self-directed behaviours (e.g., scratching) in younger orangutans, compared to older individuals, and increased auto-grooming in older individuals. Scratching was positively correlated with FGM concentrations.	Negative	(Amrein <i>et al.</i> 2014)
Sumatran orangutans and western lowland gorillas	Interactions and familiarity	Behaviour	The more unfamiliar humans were, the more negative interactions were between the unfamiliar humans and apes i.e., increased hiding and aggression and decreased affiliative behaviours by the apes.	Negative	(Smith 2014)
Orangutans	Visual contact	Behaviour	When the visitor viewing area window was open to visitors, orangutans showed a preference to position themselves facing towards the open window compared to when either the right or left side of the window was partially covered.	Positive	(Bloomfield <i>et al.</i> 2015)
Black-capped capuchins	Visual contact vs. no visual contact	Behaviour and FGM	When visual contact with visitors was obscured, capuchin aggression, FGM concentrations, abnormal behaviours and avoidance of the visitor viewing area decreased.	Negative	(Sherwen <i>et al.</i> 2015b)
Crowned lemurs	Visitor-animal feeding	Behaviour	During visitor feeds compared to keeper-only feeds, lemurs spent less time performing aggressive behaviour and increased interactions with visitors.	Positive	(Jones <i>et al.</i> 2016)

Species	Visitor Variables	Animal Variables	Key findings	Suggested visitor effect	Reference
Chimpanzees and ring-tailed lemurs	Number	Wounding aggression rates	The pattern of wounds did not correlate with mean visitor number through the gates for either species in any group. No correlation between high visitor number and increased wounding in these two species when housed in zoos.	Neutral	(Hosey <i>et al.</i> 2016)
Western lowland gorillas	Number	Behaviour	As visitor number increased, gorillas increased sitting with their backs to the viewing window, foraged less and were more inactive. The adult male was more aggressive when visitor number increased. However, negative effects of visitors were lessened when an infant was born. The adult male foraged more, was less inactive and more social after the infant's birth when visitor number was high. Aggression and sitting with backs to viewing window, were not diminished with the birth of the infant.	Negative	(Collins and Marples 2016)
Chimpanzees and Western lowland gorillas	Number	Behaviour	As crowd size increased, there was no change in the use of areas in the enclosure closest to zoo visitors by chimpanzees and gorillas. There was no effect of on the frequency of abnormal behaviours, agonism, and grooming. Crowd size had a slight effect on self-directed behaviours in both species.	Neutral	(Bonnie <i>et al.</i> 2016)
Lemurs	Number and behaviour	Behaviour	When visitor number increased, lemurs increased locomotion. Visitor behaviour had no effect on lemur behaviour. There was a weak positive correlation between crowd size and behavioural diversity. The presence of a	Neutral	(Collins <i>et al.</i> 2017)

Species	Visitor Variables	Animal Variables	Key findings	Suggested visitor effect	Reference
			baby stroller was associated with reductions in locomotion and grooming.		
Squirrel monkeys	Number	Behaviour	When there were large groups of visitors present, squirrel monkeys spent more time by the window compared to when there were small groups, or no visitors present.	Positive	(Polgar <i>et al.</i> 2017)
Spider monkeys	Presence vs. absence	Behaviour	Increased self-directed behaviours and decreased vocalisations by spider monkeys were associated with visitor presence. When visitors fed the monkeys, agonistic behaviours increased.	Negative	(Pérez-Galicia <i>et al.</i> 2017)
Orangutans and gorillas	Familiarity	Behaviour	The apes performed more human-directed behaviours toward visitors than staff including increased visitor-directed visual behaviour (e.g., brief glances). Increased visual monitoring or vigilance of visitors by apes may be considered as fearful behaviour or may be a potential indicator of curiosity.	Unclear	(Pedersen <i>et al.</i> 2019)
Chimpanzees	Number, controlled visitor conditions: public access only via a guided visit	Behaviour	There was only a slight increase in locomotion and decrease in inactivity by chimpanzees when visitors were present and in small groups compared to larger groups of visitors or when visitors were absent. Chimpanzees showed more interest towards visitors when in larger group sizes.	Neutral	(López-Álvarez <i>et al.</i> 2019)

Species	Visitor Variables	Animal Variables	Key findings	Suggested visitor effect	Reference
	under strict supervision				
Japanese Macaques	Number and activity level	Social rank and behaviour	The social rank of the macaques was a significant predictor of visitor-directed aggression, with lower-ranked individuals displaying more frequent aggression towards visitors. Visitor-directed aggression increased as visitor activity levels increased (i.e., frenetic – running and yelling) but was not associated with crowd size.	Negative	(Woods <i>et al.</i> 2019)
Sulawesi crested Macaques	Number and noise	Behaviour	Active behaviours (e.g., locomotion or foraging) and vigilance increased and resting, and social huddling decreased as visitor number and noise level increased. Signage, with and without salient human eyes, reduced visitor noise levels slightly compared to no signage.	Unclear	(Dancer and Burn 2019)
Ebony langurs	Number, noise, activity level	Behaviour	The higher visitor impact scores (i.e., increased visitor numbers, noise levels and activity), predicted the increased expression of displacement, affiliative and aggressive behaviours in the ebony langurs.	Negative	(Roth and Cords 2020)
<i>Felids</i>					
Cheetahs	Presence vs. absence and noise	Behaviour	No visitor effects on behaviour or spatial location.	Neutral	(O'Donovan <i>et al.</i> 1993)

Species	Visitor Variables	Animal Variables	Key findings	Suggested visitor effect	Reference
Indian leopards	Presence vs. absence	Behaviour	Leopards exhibited higher levels of activity when on-exhibit on days with no visitors. Stereotypic pacing was not influenced by the presence of visitors or by feeding time. Higher levels of stereotypic pacing were observed off-exhibit compared to on-exhibit enclosures.	Negative	(Mallapur and Chellam 2002)
Lion, amur leopard, amur tiger, snow leopard, clouded leopard, fishing cat	Presence vs. absence	Behaviour	No significant differences in activity based on the presence or absence of visitors for any of the seven felid exhibits.	Neutral	(Margulis <i>et al.</i> 2003)
Jaguar	Number and noise	Behaviour	Both jaguars spent more time nonvisible at the lowest visitor density and noise intensity levels. The male increased aggression towards conspecifics at higher visitor densities. Intermediate visitor intensity, or noise levels, increased pacing behaviour of the female jaguar. Visitor density and noise intensity did not affect any other jaguar behaviours.	Negative	(Sellinger and Ha 2005)
Pumas	Number and noise	Behaviour	Both pumas increased time spent inactive and engaged in visitor-directed vigilance when visitor number and noise level increased.	Negative	(Maia <i>et al.</i> 2012)
Jaguars	Number	Behaviour	All jaguars increased time spent pacing as visitor number increased. This was reduced with the addition of cinnamon	Negative	(Vidal <i>et al.</i> 2016)

Species	Visitor Variables	Animal Variables	Key findings	Suggested visitor effect	Reference
			and black pepper as environmental enrichment within their enclosure.		
Royal Bengal tigers and Indian leopards	Number	Behaviour and FGM	On high visitor number days, tigers showed lower stereotypic behaviour compared to days with low or no visitors. Leopards increased stereotypic behaviour on high visitor number days.	Neutral for tigers Negative for leopards	(Vaz <i>et al.</i> 2017)
Eurasian lynx, jaguar, bobcat, ocelot, and Asiatic lion	Presence vs. absence and number	Behaviour	When the zoo was open to the public, lynxes, bobcats, and ocelots spent less time playing and walking and more time resting. Lions spent less time engaged in abnormal behaviours when the zoo was open. Ocelots and bobcats made more use of hidden spaces and less use of areas close to visitors. The jaguar spent more time playing when the zoo was open to the public. Visitor density was not associated with animal activity.	Positive for jaguar Negative the other species	(Suárez <i>et al.</i> 2017)
Servals	Behind the scenes encounters and interactive presentations	Behaviour and FGM	The cats reduced stereotypic pacing on weeks when participating in interactive presentations, or when combined with the behind-the-scenes encounters. The behavioural diversity of the cats was strongly reduced on weeks when cats participated in both activities. No effect was found on adrenocortical activity.	Positive	(Acaralp-Rehnberg <i>et al.</i> 2020)

Species	Visitor Variables	Animal Variables	Key findings	Suggested visitor effect	Reference
<i>Other Carnivora</i>					
Fennec fox	Number	Behaviour	Higher number of visitors was correlated with increased frequency of stereotypic running.	Negative	(Carlstead 1991)
Giant pandas	Noise	Behaviour and urine glucocorticoids	Days characterised by louder levels of noise were associated with increased locomotion, restlessness, scratching and vocalisations indicative of agitation, and increased urine glucocorticoids.	Negative	(Owen <i>et al.</i> 2004)
Mexican wolf	Number	Behaviour and FGM	The wolves spent less time lying and eating on days with higher visitation numbers compared to days with lower visitation. Wolves had higher faecal cortisol on Sundays compared to the other 3 days (i.e., Saturday, Monday, and Tuesday), which was the highest visitation day out of the four days.	Negative	(Pifarré <i>et al.</i> 2012)
Harbour seals	Number	Behaviour	On days with high visitor attendance, more seals were spent time submerged under water and fewer seals scanned the environment and rested on land compared to days with low visitor attendance. As visitor numbers increased, more seals swam under water and fewer seals swam with their heads above water and fewer engaged in social behaviour.	Negative	(Stevens <i>et al.</i> 2013)
Meerkats	Number, noise, and behaviour	Behaviour	Regulated visitor behaviour using signage that reduced the intensity of visitor behaviour, had no effect on meerkat behaviour.	Neutral	(Sherwen <i>et al.</i> 2014)

Species	Visitor Variables	Animal Variables	Key findings	Suggested visitor effect	Reference
Polar bears	Number	Behaviour	All bears were affected by visitor presence but there was individual variation. As visitor numbers increased, this was associated with increased stereotypical behaviour in one female and decreased in the other two bears. The female was more inactive during times of low visitor density while the male was more inactive when there were high visitor numbers.	Depended on individual: negative for 1 female; positive for the remaining two bears	(Kelly <i>et al.</i> 2015)
Meerkats	Number	FGM	FGM increased as the median number of visitors increased. The higher the variation in visitor number, the lower the FGM concentrations. Low FGM levels were observed when animals were exposed to a low number of visitors and high FGM level were when meerkats were exposed to consistently high numbers of visitors throughout the day.	Negative	(Kay Scott <i>et al.</i> 2017)
Californian Sea lions and harbour seals	Presence vs. absence	Behaviour	When visitors were present, no change in seal behaviour was found. There was a preference for the water bordering the visitor viewing areas during these times. During the study, two sea lions gave birth and showed a preference for land areas both adjacent to and out of sight of visitors when nursing compared to during pregnancy. The presence of visitors increased vigilance and feeding in the harbor seals. Visitor presence was associated with increased preference for water areas adjacent to the visitor viewing area which	Neutral	(de Vere 2018)

Species	Visitor Variables	Animal Variables	Key findings	Suggested visitor effect	Reference
			was likely due to visitors being able to purchase fish to throw to the animals.		
<i>Ungulates</i>					
Zulu suni, slender horned gazelle, Dorcas gazelle, yellow-back duiker, Mhorr's gazelle, lowland nyala, Nile lechwe, Arabian oryx, bongo antelope, sable antelope, greater kudu	Presence vs. absence	Behaviour	Intraspecific vigilance increased when the public was present.	Unclear	(Thompson 1989)
Soemmerring's gazelle	Number	Behaviour	The group of gazelles in the enclosure most concealed from visitors showed lower agonistic interactions compared to gazelles in enclosures most accessible to visitors.	Negative	(Mansour <i>et al.</i> 2000)
Black rhinoceros	Proportion of enclosure exposed to the public	Behaviour FGM	Black rhinos in enclosures that had a higher proportion of the perimeter exposed to the public, had higher mean faecal corticoid concentrations	Negative	(Carlstead and Brown 2005)
Indian gaur	Presence vs. absence	Behaviour	On days when visitors were present, movement and intra-group aggression increased, and resting behaviour decreased compared to days with no visitors.	Negative	(Sekar <i>et al.</i> 2008)

Species	Visitor Variables	Animal Variables	Key findings	Suggested visitor effect	Reference
Asian elephants and Indian rhinoceros	Presence vs. absence	Salivary cortisol	When the zoo was opened to visitors, salivary cortisol concentrations were found to increase compared to during pre- and post-opening periods.	Negative	(Menargues <i>et al.</i> 2008)
Sika deer	Number	Behaviour	Decreased time spent foraging and increased time spent watching, resting and non-visible were associated with higher visitor number.	Negative	(Shen-Jin <i>et al.</i> 2010)
Indian blackbuck	Number	Behaviour and FGM	Aggression and movement increased, and reproductive behaviours decreased when visitor numbers were high. Elevated faecal cortisol concentrations were associated with high visitor number. Time spent resting increased during periods of zero and low levels of visitors.	Negative	(Rajagopal <i>et al.</i> 2011)
Mixed-breed goats, llamas, Vietnamese pot-bellied pigs	Presence vs. absence, number and visitors grooming vs. no visitor grooming	Behaviour	No change in goat or llama behaviour was found between visitor presence and absence. Pigs reduced affiliative behaviours towards conspecifics and intra-group aggression when visitors were present compared to absent. Non-aggressive interactions with the public increased for all three study species as visitor numbers increased. The level of avoidance or aggression towards visitors was not dependent on density. No behavioural change was observed in either goats or pigs when groomed or not groomed by visitors.	Positive/Neutral	(Farrand <i>et al.</i> 2014)

Species	Visitor Variables	Animal Variables	Key findings	Suggested visitor effect	Reference
Giraffes	Visitor feeding	Behaviour	Participation in guest feeding programs (GFPs) was associated with increased time spent idle and reduced time spent ruminating, particularly if GFPs occurred all-day. GFPs had no effect on performance of stereotypic behaviours. When time spent eating routine diets was combined with time spent participating in guest feeding programs, individuals that spent more time engaged in feeding tended to perform less oral stereotypic behaviour such as object-licking and tongue-rolling.	Unclear	(Orban <i>et al.</i> 2016)
Collared peccaries	Musical concert vs. no concert	Behaviour	On concert days, the solitary-housed peccary increased resting and the use of the back and front to the enclosure compared to days with no concert. The peccaries housed as a group slept more in the afternoon and evening and were more vigilant at night on concert days compared to days with no concert.	Unclear	(Fanning <i>et al.</i> 2020)
<i>Marsupials</i>					
Koalas	Presence vs. absence	Heart rate	When exposed to visitors, koalas were found to have higher resting heart rates compared to visitor absence.	Negative	(Ropert-Coudert <i>et al.</i> 2009)
Koalas	Handling vs. no handling	FGM	The FGM levels of female koalas were not affected by handling by visitors as long as the koalas were not lactating.	Depended on sex:	(Narayan <i>et al.</i> 2013)

Species	Visitor Variables	Animal Variables	Key findings	Suggested visitor effect	Reference
			Male koalas that were handled by visitors had higher FGM levels compared to a male group that was not handled.	Neutral for females Negative for males	
Koalas	Number and noise	Behaviour	Increased visitor number and noise level increased vigilance.	Negative	(Larsen <i>et al.</i> 2014)
Kangaroo Island kangaroos & Red kangaroos	Number	Behaviour and FGM	When visitor number increased, both species of kangaroos increased time spent in visitor-directed vigilance. Kangaroo Island kangaroos increased time spent engaged in locomotion and decreased time spent resting as visitor number increased. There was no effect of visitor number on the distance kangaroos positioned themselves from the visitor pathway or FGM concentration in either species.	Neutral	(Sherwen <i>et al.</i> 2015a)
Koalas	Visitor encounter: no photography, intensive photography, and standard photography sessions	FGM	The more frequent visitor photography sessions were, the higher FGM levels were in male koalas. Female koalas did not show a change in FGM levels in response to the change in photography frequency but did between no photography sessions and photography sessions.	Negative	(Webster <i>et al.</i> 2017)

Species	Visitor Variables	Animal Variables	Key findings	Suggested visitor effect	Reference
Quokka	Presence vs. absence	Behaviour	When the exhibit was open to visitors, fewer quokkas were visible from the visitor paths compared to when the exhibit was closed to visitors.	Moderately negative	(Learmonth <i>et al.</i> 2018)
Rodents					
Black-tailed prairie dog	Number	Behaviour	Adult prairie dogs increased resting and allogrooming and decreased foraging, vigilance, traveling and performance of “other” behaviours as the number of visitors increased. For the pups, resting, allogrooming and travelling increased while vigilance decreased as visitor numbers increased.	Neutral to positive	(Eltorai and Sussman 2010)
European Red Squirrels	Number, noise, visitor duration	Behaviour	Squirrels increased interaction with visitors as the number of visitors inside the enclosure increased. The number of children present also increased locomotion and decreased eating in the squirrels. The number of adult visitors increased eating and decreased inactivity in the squirrels as a result of the positive reinforcement training used by the keepers where the squirrels learnt to associate adult visitors with food opportunities. Squirrel encounter rate (number of squirrels seen by each group of visitors) increased as the number of adults and visitor duration increased. Squirrel encounter rate decreased as noise level increased.	Positive	(Woolway and Goodenough 2017)

Species	Visitor Variables	Animal Variables	Key findings	Suggested visitor effect	Reference
Other Mammals					
Bush dog, Chimpanzee, Coatis, Common eland, Fallow deer, Gorilla, Grison, Howler monkey, Lion, Mandrill, Maned wolf, Marsh deer, Ocelot, Puma, Red deer, Tiger, Titi monkey	Number and noise	Behaviour	The presence of visitors mostly affected locomotive behaviour across species. Carnivorous animals were less affected by visitors than herbivorous or omnivorous animals. Terrestrial animals were more affected by visitors than arboreal animals and if in closed habitats compared to open habitat species. Diurnal species were more affected by visitors than nocturnal animals. The presence of visitors resulted in changes in mammal behaviour where there was a significant increase in the frequency of resting and locomotion behaviours.	Depended on species	(Queiroz and Young 2018)
The lesser or collared Anteater	Presence vs. absence	Behaviour	No effect of days the zoo was opened or closed to visitors on anteater behaviour.	Neutral	(Chiapero <i>et al.</i> 2020)
Aves					
Corella	Number	Behaviour	On quiet days when there were fewer visitors present, the corella spent more time initiating interactions with visitors compared to busy days with lots of visitors present.	Positive	(Nimon and Dalziel 1992)
Humboldt penguins	Presence vs. absence, number, and noise	Behaviour	When visitors were present, penguins spent more time submerged swimming and less time swimming at the water's surface and resting compared to visitor absence. When only noise was considered, quiet visitor groups increased the time penguins spent surface swimming. When	Positive	(Condon <i>et al.</i> 2003)

Species	Visitor Variables	Animal Variables	Key findings	Suggested visitor effect	Reference
			visitors were loud penguins spent more time submerged swimming. When only visitor numbers were considered, small visitor groups increased resting, preening, and submerged swimming. Large visitor groups increased surface swimming.		
Greater Rheas	Presence vs. absence	Behaviour	When visitors were present, greater rheas increased walking alert. Defecating/urinating and other behaviours were mostly expressed in visitor absence.	Neutral	(de Azevedo <i>et al.</i> 2012)
Red-billed choughs, northern lapwings, red-crested turacos, Madagascar teal, grey gulls, Palawan peacock pheasant.	Presence vs. absence and number	Behaviour and enclosure use	When visitors were present, red-billed choughs and grey gulls were located in the front zones of the enclosure compared to visitor absence. As visitor numbers increased, all the birds, except the Madagascar teal and the Palawan peacock pheasant, increased active behaviours such as locomotion, feeding, bathing, preening, and vocalising.	Unclear – potentially positive	(Downes 2012)
African penguins	Presence vs. absence and number	Behaviour	African penguins increased avoidance of visitors and decreased time spent in their pool when visitors were present in a pool adjacent to the penguin pool, especially in large numbers.	Negative	(Ozella <i>et al.</i> 2014)
Little penguins	Presence vs. absence	Behaviour	When visitors were present, penguins increased aggression, huddling and time spent positioned behind enclosure features and increased distance from the visitor viewing area.	Negative	(Sherwen <i>et al.</i> 2015c)

Species	Visitor Variables	Animal Variables	Key findings	Suggested visitor effect	Reference
Citron-crested and Moluccan cockatoos	Presence vs. absence and number	Behaviour	When zoos visitors were present in a nearby playground, citron-crested cockatoos did not retreat from visitors and became more active and social when there were high visitor numbers present. Moluccan cockatoos retreated from visitors where one individual increased vocalisations and the other individual spent less time resting as visitor number increased.	Positive for citron-crested cockatoos Negative for Moluccan cockatoos	(Collins and Marples 2015)
Gentoo penguins	Number, behaviour	Behavioural diversity	As visitor number increased, behavioural diversity and pool use by the penguins increased.	Positive	(Collins <i>et al.</i> 2016)
African penguins	Number	FGM	The number of visitors did not affect the adrenocortical activity of the African penguins.	Neutral	(Ozella <i>et al.</i> 2017)
African penguins	Non-Contact Animal Encounter Program	Behaviour	No changes in the penguin colony's affiliative and aggressive behaviour as well as human-directed behaviours were found between days with or without the encounter program. This was also found when comparing behaviour preceding the encounter to a matched control period, indicating that any anticipatory period was non-disruptive. Space use by the penguins during encounters suggested comfort near visitors.	Neutral	(Saiyed <i>et al.</i> 2019)
24 bird species housed in a free-flight, mixed species aviary	Number and noise	Behaviour	All species, except for the African openbill, blue-breasted kingfisher, great curassow, and scarlet ibis, showed an avoidance of the visitor pathway, increased use of	Negative	(Blanchett <i>et al.</i> 2020)

Species	Visitor Variables	Animal Variables	Key findings	Suggested visitor effect	Reference
			vegetation cover and decreased range size as visitor numbers and noise level increased.		
Black-casqued hornbill	Number	Behaviour	Visitor number had no effect on hornbill behaviour or enclosure use. There was an interaction between visitor number and keeper presence on the hornbill's interest in the keeper where the birds became less interested in the keeper as visitor numbers increased.	Neutral	(Rose <i>et al.</i> 2020)
Fiordland penguins	Musical concert vs. no concert	Behaviour	When musical concerts occurred, Fiordland penguins increased use of a nest and pool and decreased time spent preening and interacting with the habitat compared to days with no concerts.	Unclear	(Fanning <i>et al.</i> 2020)
<i>Herpetofauna and Fish</i>					
Galápagos giant tortoise	Presence vs. absence	Behaviour	On days with visitors compared to control days (only keepers), the female giant tortoises increased the median number of aggressive interactions. This behaviour also increased as visitor number increased. Tortoise activity decreased in the presence of visitors.	Negative	(Freeland <i>et al.</i> 2020)
Cownose ray, Southern stingray, Bonnethead shark, Brown banded bamboo shark, White-spotted bamboo shark	Number and behaviour	Behaviour	As visitor numbers increased along the perimeter of the direct-contact touch pool, the cownose ray decreased social behaviour and increased solitary behaviour. When food was provisioned by visitors (into the exhibit pool), the southern stingray increased swimming and decreased resting	Neutral for Brown-banded and White-spotted bamboo sharks	(Boyle <i>et al.</i> 2020)

Species	Visitor Variables	Animal Variables	Key findings	Suggested visitor effect	Reference
			behaviours and bonnethead sharks increased time spent in the periphery of the exhibit. The two species of nocturnal sharks (brown-banded and white-spotted bamboo sharks) showed no behavioural changes.	Negative for cownose ray if no food provision Negative for Bonnethead shark	

1.3.2 The effect of zoo animals on visitors

Most research to date specifically on zoo visitors has been on examining the effects of zoos and the zoo experience on visitors' knowledge of and attitudes towards zoo animals (Miller *et al.* 2013; Pearson *et al.* 2013; Pearson *et al.* 2014a; Pearson *et al.* 2014b; Roe *et al.* 2014; Godinez and Fernandez 2019; Mellish *et al.* 2019; Kleespies *et al.* 2020). There has also been a considerable amount of focus on evaluating the impacts of zoo enclosure design on visitors (Bitgood *et al.* 1988; Shettel-Neuber 1988; Davey 2006b; Moss *et al.* 2010; de Young *et al.* 2011). For example, 'naturalistic' enclosures have been associated with increased positive visitor perceptions of and attitudes towards the welfare of zoo animals and improved visitor experiences (Rhoads and Goldsworthy 1979; Finlay *et al.* 1988; Tofield *et al.* 2003; Melfi *et al.* 2004; Nakamichi 2007; Lukas and Ross 2014; Luebke *et al.* 2016). Free-range enclosures, which promote natural or species-specific behaviour in zoo animals, have also been shown to improve visitor perceptions of the welfare of zoo animals, visitor experience and increase visitor viewing times (Price *et al.* 1994; Mun *et al.* 2013; Bryan *et al.* 2017). Also, conservation campaigns or programs, as part of the zoo experience, have been found to increase positive visitor perceptions of and attitudes towards zoo animals and promote conservation awareness (Clayton *et al.* 2009; Pearson *et al.* 2014b; Mellish *et al.* 2019). Research on the impacts of zoos and the zoo experience on visitors is important as it helps determine how effectively zoos are educating visitors about wildlife and promoting behavioural change in visitors to help conservation efforts (Godinez and Fernandez 2019; Howell *et al.* 2019).

With the substantial increase in research on visitor effects on zoo animals, there is growing evidence that zoo animals, especially their behaviour, can also affect visitors. The effects of zoo animals on visitors are important to understand as it provides more comprehensive insights on how both visitors and animals may influence one another. Research on the effects of zoo animals has primarily been on their influences on visitor perceptions of and attitudes towards zoos and their animals, visitor behaviour and visitor experience (Margulis *et al.* 2003; Miller 2012; Godinez *et al.* 2013; Godinez and Fernandez 2019). For example, the size, colour, visibility, activity, and rarity of an animal has been shown to affect visitor viewing times at exhibits (Bitgood *et al.* 1988; Reynolds and Braithwaite 2001; Margulis *et al.* 2003; Angulo *et al.* 2009; Moss and Esson 2010; Whitworth 2012). In particular, increased visitor viewing times, attitudes and perceptions of zoos and zoo animals has been positively associated with increased visibility and activity of animals (Altman 1998; Sellinger and Ha 2005; Davey 2006a; Godinez *et al.*

2013). Furthermore, there is evidence that zoo presentations and shows that display species-specific behaviour of zoo animals can increase conservation-related knowledge, visitor attitudes, viewing times and improve visitor experiences (Moss and Esson 2010; Miller *et al.* 2013; Godinez and Fernandez 2019). For instance, Anderson *et al.* (2003) found that visitors who viewed positive reinforcement training of Asian small-clawed otters (*Aonyx cinereus*), had more positive zoo experiences, perceptions and longer viewing times at the otter exhibit compared to visitors that were not exposed to the otter training sessions. These training sessions involved otters engaging in behaviours which facilitated aerobic activity, safe husbandry and veterinary procedures (Anderson *et al.* 2003). Miller *et al.* (2013) also found that visitors who attended dolphin shows and/or dolphin interaction programs had increased knowledge, attitudes, and behavioural intentions to engage in conservation-related behaviours for dolphins compared to visitors that only viewed dolphins on display or did not view dolphins at all.

Compared to the extensive research on visitor effects (section 1.3.1 of this review), the effects of zoo animals on visitors, in the context of visitor-animal interactions, has received little attention over the past several decades and therefore, remains poorly understood. A measure of this is shown by the number of reviews on these topics. There have been five reviews on the effects of visitors on zoo animals (Hosey 2000; Davey 2007; Fernandez *et al.* 2009; Hosey 2013; Sherwen and Hemsworth 2019). In comparison, there have only been three reviews on the effects of zoos/exhibits/animals on visitors, only one of which was in the context of visitor-animal interactions (Davey 2006b; Fernandez *et al.* 2009; Godinez and Fernandez 2019). Fernandez *et al.* (2009) critically reviewed the effects on visitors' perceptions, attitudes, and behaviours as a result of animal behaviour and the way animals are exhibited in zoos. The review was in a broad context of visitor-animal interactions and recommended that the education of visitors and exhibit design are important ways to manage visitor interactions with animals (Fernandez *et al.* 2009). However, there is a lack of theoretical understanding of why visitors behave in certain ways towards zoo animals which may be more fundamentally important to manage visitor-animal interactions. As a result, our understanding of the effects of zoo animals on the attitudes and the experience of visitors, in the context of the visitor-animal interactions, remains limited (Fernandez *et al.* 2009; Hosey and Melfi 2014; Hosey *et al.* 2020). It is important for zoos to understand how zoo animals and their interactions with visitors affects visitor attitudes and experience because attitudes are drivers of behaviour (Ajzen 1991). The relationship between human attitudes and behaviour is based on the

Theory of Planned Behaviour which attempts to explain and predict a person's behaviour (Ajzen 1985; Ajzen 1991). It proposes that the beliefs a person holds regarding a particular object, forms the attitudes of a person and their subjective norms, which in turn can predict and determine a person's intention and behaviour (Ajzen 1985; Ajzen 1991).

As previously mentioned in section 1.3, the nature of stockpeople-livestock interactions can be influenced by a stockperson's attitude towards animals (Hemsworth *et al.* 1994; Coleman *et al.* 2000; Hanna *et al.* 2009). For example, positive attitudes towards livestock and working with livestock, have been shown to decrease aversive behaviours by stockpeople and result in positive outcomes on animal behaviour and welfare (Hemsworth and Coleman 2011; Munoz *et al.* 2019). Therefore, understanding visitor attitudes towards zoo animals, visitor experience and the factors that may influence these aspects of visitors (attitudes and experience), may help explain the way visitors behave towards zoo animals. This has important implications on the development of human behaviour change interventions to assist in safeguarding the welfare of zoo animals and positive visitor experiences.

1.4 Gaps in the visitor effect literature

Research on visitor effects on the behaviour and welfare of zoo animals has shown visitors are not simply a passive part of the zoo environment for many zoo species (Davey 2007; Hosey and Melfi 2014; Sherwen and Hemsworth 2019). But there have been mixed findings in the visitor effect literature. This variation may be attributed to species-specific differences, individual animal characteristics, experiential effects, enclosure design which may alter the nature and intensity of visitor interactions, and flaws in interpretation (Morgan and Tromborg 2007; Fernandez *et al.* 2009; Mason 2010; Cockrem 2013; Queiroz and Young 2018; Sherwen and Hemsworth 2019). As a result, we still have limited understanding of the complex relationship between zoo visitors and animals. Furthermore, there has been insufficient development of strategies to manage visitor-animal interactions because our understanding of the zoo visitor-animal relationship remains incomplete. There are several knowledge gaps that have contributed to our limited understanding of the zoo visitor-animal relationship and the existing inconsistencies within the literature. These knowledge gaps have included a lack of understanding of 1. Visitor effects on understudied taxa (Research bias); 2. The cause of zoo animals responding to visitors negatively, positively, or neutrally (Cause and effect);

3. The specific aspects of visitors or visitor contact that affect zoo animals (Visitor variables examined); 4. The factors that influence visitor-animal interactions across zoos (Multi-institutional studies); and 5. The sociological aspect of the zoo visitor-animal relationship (Visitor attitudes and experience).

1.4.1 Research bias

Even though the relationship between visitors and zoo animals has been increasingly studied over the past several years, this relationship remains poorly understood across taxa (Hosey 2005; Davey 2007). Zoos house an extensive range of species where recent data retrieved from the Zoological Information Management System showed that zoo facilities worldwide currently house over 235,000 mammals, 230,000 birds, 50,000 reptiles and nearly 300,000 invertebrates (Ward and Sherwen 2018; Hosey *et al.* 2020). Yet, the visitor effect literature has been primarily focused on charismatic mammals, particularly non-human primates, and other taxa such as birds and reptiles have been neglected (Davey 2007; Smith 2016; Sherwen and Hemsworth 2019; Hosey *et al.* 2020; Rose *et al.* 2020). This is further supported by Table 1.1 (section 1.3.1) where about 85% of the studies on visitor effects have been on mammals (45% on non-human primates, 18% on carnivore species, 11% on ungulates and 11% on other mammal species), about 14% on birds and 2% on reptiles and fish. This research bias is a concern as mammals are not the only charismatic and threatened group of animals held in captivity. The International Species Information System (ISIS), now known as Species 360, which is a network of more than 800 zoos and aquariums, also shows that 23% of terrestrial vertebrate species in zoos are threatened; 8% birds, 27% mammals, 40% reptiles and 25% amphibians (Conde *et al.* 2013; Guenter 2016). Thus, the current research bias in the literature has led to major gaps in knowledge on visitor effects across taxa that could potentially have impacts on conservation programs (Davey 2007; Fernandez *et al.* 2009; Melfi 2009; Sherwen and Hemsworth 2019; Hosey *et al.* 2020). It is critical for zoos to understand the effects of visitors on all commonly zoo-housed species so that zoos can gain further understanding of the visitor-animal relationship. Through this understanding, management strategies can be developed to manage the interactions between zoo visitors and animals and allow for the continuous improvement of animal welfare and visitor experience.

A good example of an understudied taxon within the visitor effect literature are penguins. Penguins (order Sphenisciformes; family Spheniscidae) are commonly housed in zoos and are considered to be a charismatic species because of their aesthetic appeal, perceived “cuteness” and ability to invoke a large amount of emotional affinity (Woods 2000; Stokes 2007; Tucker 2007; Seddon and Ellenberg 2008; Colléony *et al.* 2017). Yet,

there is limited research on the effect of visitors on zoo-housed penguins (Hosey 2008). Most of our current understanding of the human-penguin relationship has been obtained from research on wild penguin populations due to the popularity of penguin ecotourism (Stokes 2007; Seddon and Ellenberg 2008; Ellenberg 2009; Borboroglu and Boersma 2013). However, with this popularity, there have been growing concerns of the effects of human disturbance on wild penguin populations (Seddon and Ellenberg 2008; Ellenberg *et al.* 2012; Villanueva *et al.* 2012). Human disturbances are defined as any human activity that results in behavioural or physiological change in animals (Seddon and Ellenberg 2008). There is evidence that human disturbances can have negative consequences for wild penguins (Culik and Wilson 1995; Carney and Sydeman 1999; Ellenberg *et al.* 2006; Seddon and Ellenberg 2008). For example, Adelie penguins (*Pygoscelis adeliae*) have been found to have reduced breeding success as a result of repeated human approaches and nest checks (Giese 1996). Similarly, unregulated tourism has been shown to lower breeding success and fledging weights of Yellow-eyed penguins (*Megadyptes antipodes*) (McClung *et al.* 2004; Ellenberg *et al.* 2007). Dramatic increases in heart rates and reductions in reproductive success in Humboldt penguins (*Spheniscus humboldti*) were also found at sites frequently visited by tourists (Ellenberg *et al.* 2006). Furthermore, King (*Aptenodytes patagonicus*), Gentoo (*Pygoscelis papua*) and Royal penguins (*Eudyptes schlegeli*) increase vigilance and agonistic behaviours in response to human approach (Holmes *et al.* 2006; Holmes 2007). Even wild little penguin populations in Australia, have shown avoidance of nesting areas when exposed to high levels of human visitation (Giling *et al.* 2008).

Research has also found that certain species of penguins in the wild can habituate to human contact, depending on their previous experience and the amount of exposure to humans. Magellanic penguins (*Spheniscus magellanicus*) that are frequently exposed to high levels of human visitation were found to have lower plasma corticosterone levels, lower rates of alternate stares/head turns (a defensive behaviour) and vocalizations (Fowler 1999; Villanueva *et al.* 2012). Also, Magellanic penguins have been shown to allow closer approaches by people in tourist areas compared to areas rarely visited by tourists (Yorio and Boersma 1990). Magellanic penguins with no previous exposure to tourists, also rapidly habituate to human visitation, evident through significant reductions in plasma corticosterone concentration after just 5 days of daily visits by humans (Walker *et al.* 2006). Wild Yellow-eyed penguins have also been found to habituate to human contact. Ratz and Thompson (1999) found no detrimental impact of tourists on Yellow-eyed penguins shown by an increased number of nests visible and no difference in breeding success between the tourist visited colony and colony with no

public access. Yellow-eyed penguins have also been suggested to habituate to short and consistent approaches by tourists but not to unregulated tourist visits at nest sites (Ellenberg *et al.* 2009). It is clear that there is variation in the wild penguin literature similar to that observed in the visitor effect literature. Therefore, further research is still required to understand the effects of visitors on penguins.

From the range of research on wild penguin populations, it is evident that visitors can have varying effects on different species of penguins in the wild. However, little is known about the effects of visitors on zoo-housed penguins. Only four studies, thus far, have examined the effects of zoo visitors on some commonly housed species of penguins. For example, zoo-housed African penguins and little penguins are negatively affected by visitor presence, shown by reduced pond use and increased aggression, huddling and avoidance behaviours, respectively (Ozella *et al.* 2014; Sherwen *et al.* 2015c). In contrast, zoo-housed Humboldt penguins and aquarium-housed Gentoo penguins are positively affected by visitors, evident through the increased swimming behaviour and behavioural diversity as visitor numbers increased. These mixed findings, as previously mentioned, may be the result of various factors such as species-specific differences, enclosure design and past experiences. Therefore, there is still a need for further research to understand the effects of visitors on an understudied taxon such as penguins, both in the wild and zoo settings.

1.4.2 Correlation studies: lack of cause and effect

Within the visitor effect literature, numerous studies have been designed as observational studies where correlations are often used to examine the relationships between animal behaviour and physiology and the natural variation in visitor conditions (e.g. visitor numbers) (Sherwen and Hemsworth 2019). By using correlations, a direct cause and effect relationship is difficult, if not impossible, to determine and rather shows an association between two variables (Bloomfield *et al.* 2015; Sherwen and Hemsworth 2019). Results from these observational studies cannot be used as evidence of causation, as other uncontrolled factors may also be associated with the changes in behaviour or physiology (e.g., weather and season). Using a classic experimental design to conduct a “cause and effect” experiment, involves researchers randomly assigning treatments to experimental units (e.g. a population of animals) (Cochran and Cox 1957). This type of study design allows researchers to examine whether the imposed treatment(s) causes a change in the experimental units. It is, therefore, more reliable in establishing cause and effect compared to observational studies. There is growing research in the visitor effect literature that applies the classic experimental design paradigm (Sherwen *et al.* 2014;

Bloomfield *et al.* 2015; Sherwen *et al.* 2015a; Sherwen *et al.* 2015b; Sherwen *et al.* 2015c; Learmonth *et al.* 2018; Acaralp-Rehnberg *et al.* 2020). It should be noted that observational studies are still important as they can highlight aspects of the visitor-animal relationship that would require further experimental examination. Therefore, observational studies can provide the rationale for future experiments to be designed around to reliably establish cause and effect.

1.4.3 Visitor variables

As previously discussed in section 1.3.1 of this review, it is evident that visitors can have a range of effects on zoo animals. Yet, it remains unclear what it is about visitor conditions or the visitors themselves that induces these changes in animal behaviour and physiology. This knowledge gap has been driven by the examination of only a single visitor variable (e.g., visitor numbers or the presence and absence of visitors) for most of the research on visitor effects (Table 1.1). Take for example, the numerous studies that have shown increased visitor numbers or visitor presence can negatively affect a range of zoo species, increasing behaviours indicative of stress and/or fear as well as stress physiology (Sherwen and Hemsworth 2019). Knowing that high visitor numbers or the presence of visitors results in these changes in zoo animals does not highlight practical ways for zoos to manage these effects. Rather, it suggests that reducing visitor numbers would be beneficial for many zoo species. But in practice, this is not possible or feasible as it would have detrimental impacts on visitor experience and the overall sustainable operation of zoos. It is possible that certain characteristics of visitors (e.g., age, height, gender), visitor behaviour (e.g., behaviours directed at animals to attract an animal's attention), characteristics of visitor contact, (e.g., visual contact or close viewing proximity) or a combination of these visitor factors, may affect the behavioural and physiological response of zoo animals to visitors. For example, Choo *et al.* (2011) found visitor number and activity had minimal to no effect on behaviours indicative of stress in orangutans. However, at one exhibit, if visitor numbers were more than 40, there was an increased likelihood of food soliciting by orangutans at this exhibit. Close visitor proximity also reduced play behaviour but increased the occurrence of orangutans looking at the visitors (Choo *et al.* 2011). Consequently, there is a need to understand the manner in which visitors influence zoo animals. This can be achieved by examining different aspects of visitors that may affect zoos animals.

Zoo animals are exposed to a range of visitor stimuli including visual, tactile, auditory, olfactory, and vibratory stimuli (Morgan and Tromborg 2007; Fernandez *et al.* 2009; Sherwen and Hemsworth 2019). These different visitor stimuli may be perceived by zoo

animals as potentially threatening, stimulating or irrelevant and thus, influence the way zoo animals respond to visitors. In particular, visitor stimuli that are perceived as fear-provoking or threatening by animals is of most concern for zoos as it may result in negative effects on both animal behaviour and physiology (Gray 1987; Sherwen and Hemsworth 2019). In general, visitor stimuli that may be novel and of high intensity, such as loud, large, and looming stimuli or when visitors whose interactions are close, loud, fast, and unexpected may be fear-provoking or threatening for many zoo species (Sherwen and Hemsworth 2019). The extensive research in agriculture has also shown the range of human stimuli that influences animals. For instance, aspects of human contact such as human behaviour while interacting with animals (e.g. negative handling) has been found to directly affect animal behaviour and welfare (Hemsworth and Coleman 2011). Consequently, there is a need for research to examine the effects of multiple visitor variables to increase our understanding of the manner in which visitors influence zoo animal behaviour and welfare. By identifying what it is about visitors or visitor contact that affects zoo animals, management strategies to enhance both animal welfare and visitor experience can be developed.

1.4.4 Multi-institutional studies

Multi-institutional studies, also referred to as cross-institutional studies, have been well established to be a beneficial tool to help zoos assess animal welfare and identify risk factors and/or key environmental stimuli associated with poor welfare (Shepherdson *et al.* 2004; Whitham and Wielebnowski 2013). However, this type of approach has not been often used to examine the effect of visitors on zoo animals (Sherwen and Hemsworth 2019). Conducting multi-institutional studies to examine the zoo visitor-animal relationship can be challenging because of the difficulty of having a standardised methodology that can be applied to a wide variety of conditions or environments across zoos and exhibits (Shepherdson *et al.* 2004). Nevertheless, studies that have conducted multi-institutional zoo research demonstrate the power of this approach. Some benefits have included increased replication in multiple locations and with different individuals to expand sample size (Carlstead and Brown 2005; Sherwen *et al.* 2014; Sherwen *et al.* 2015a; Pedersen *et al.* 2019). It can also help identify possible key factors, such as ontogeny and enclosure design, that may explain the variation in animal responses to visitors across zoos. Furthermore, it is important to recognise that the interactions between visitors and zoo animals are often species, site and sometimes even season specific (Wright 1998; Sherwen and Hemsworth 2019). Therefore, using a multi-institutional

approach to examine the effects of visitors on the same zoo species at multiple zoos is important. This is because the effect of visitors on a species in one enclosure at one zoo, may be different to the effect of visitors on the same species at a similar enclosure at another zoo.

1.4.5 Visitor attitudes and experience

As previously mentioned in section 1.3.2, there is increasing research that has shown zoos and their animals can affect the attitudes and experience of zoo visitors. But how zoo animals themselves affect the experience and attitude of visitors, especially towards specific zoo taxa such as birds, has been poorly understood (Hosey and Melfi 2014; Hosey *et al.* 2020). Also, there has been a lack of research to explore how visitor attitudes and experience may influence the way visitors behave towards zoo animals. Understanding the attitudes and experience of visitors and the factors that may influence these attitudes and experience is important because it is well understood that attitudes are drivers of behaviour (Ajzen 1991). The extensive research in agriculture on the human-animal relationship has shown that stockpeople with negative attitudes towards animals can result in more negative handling of livestock and thus, have negative effects on animal welfare and productivity (Hemsworth and Barnett 1989; Coleman *et al.* 2000; Hemsworth 2003; Hemsworth and Coleman 2011). These negative attitudes were also influenced by factors such as the behaviour of the animals (Hemsworth and Coleman 2011). Through this understanding, improvements in stockperson-animal interactions have been achieved by targeting stockperson attitudes to modify their behaviour towards the animals they work with (Hemsworth and Coleman 2011).

For zoos, understanding the attitudes and experience of visitors in the context of visitor-animal interactions, may help elucidate why visitors have had varying effects on zoo animal behaviour and welfare. This understanding may be a promising avenue to help better manage visitor-animal interactions that safeguards both zoo animal welfare and positive visitor experiences. Therefore, it is important to understand 1. how visitors affect zoo animals; 2. how zoo animals affect visitors (attitudes, experience, behaviour); and 3. the attitudes and experience of visitors that may drive the way they behave towards zoo animals. Visitor attitudes can then be targeted to promote behavioural change which has been observed in other animal industries (Coleman 2010; Hemsworth *et al.* 2018; Glanville *et al.* 2020). Yet, this remains poorly researched in the present literature.

1.6 Conclusions

Zoos have a responsibility to not only maintain high standards of animal welfare but also provide positive experiences for their visitors. However, these two interconnected goals can often conflict with one another. As a result, research on the zoo visitor-animal relationship has substantially increased over the past several decades. The scientific literature has shown that visitors can influence zoo animals in a variety of ways. However, the limitations in the current literature have resulted in knowledge gaps. These knowledge gaps have included a lack of understanding of visitor effects on understudied taxa such as penguins; the causes of zoo animals to respond negatively, positively, or neutrally towards visitors; the specific aspect(s) of visitors and/or visitor contact that influences zoo animal responses towards visitors; the factors that affect visitor-animal interactions; and the attitudes and experience of visitors that may influence the way they behave towards zoo animals. Therefore, more extensive research using the classic experimental research paradigm is required to better understand the both sides of the zoo visitor-penguin relationship.

Based on the gaps and current limitations in the visitor effect literature, it is proposed that a model for zoo visitor-animal relationships should adapt the Hemsworth-Coleman model of stockperson-animal interactions (Figure 1.4). A model based on this literature review has been proposed and is presented in Learmonth (2019) (Figure 1.5). The proposed model highlights how the attitudes of visitors may be examined alongside the assessment of animal welfare. In psychology, an individual's attitude is defined by three interconnected components: a person's beliefs about the object such as zoo animals (cognition), their emotional response to the object (affect) and their behavioural tendency towards the object (conation) (Ajzen 1985; Pickens 2005; Hemsworth and Coleman 2011; Albarracin *et al.* 2014). One or more of these three components can be used to infer an individual's underlying attitudes when assessed in a questionnaire containing a series of attitude statements (Pickens 2005; Hemsworth and Coleman 2011). Consequently, this proposed model for zoo visitor-animal relationships is utilised in the present thesis to examine the zoo visitor-penguin relationship from both the visitor and animal aspects. This thesis examined little penguins as the focal species and aimed to address the current gaps and limitations of the literature. By understanding both sides of the zoo visitor-penguin relationship and the possible influencing factors on this relationship, this thesis

will aid the development of appropriate strategies to manage visitor-penguin interactions to safeguard the welfare of zoo-housed little penguins and positive visitor experiences.

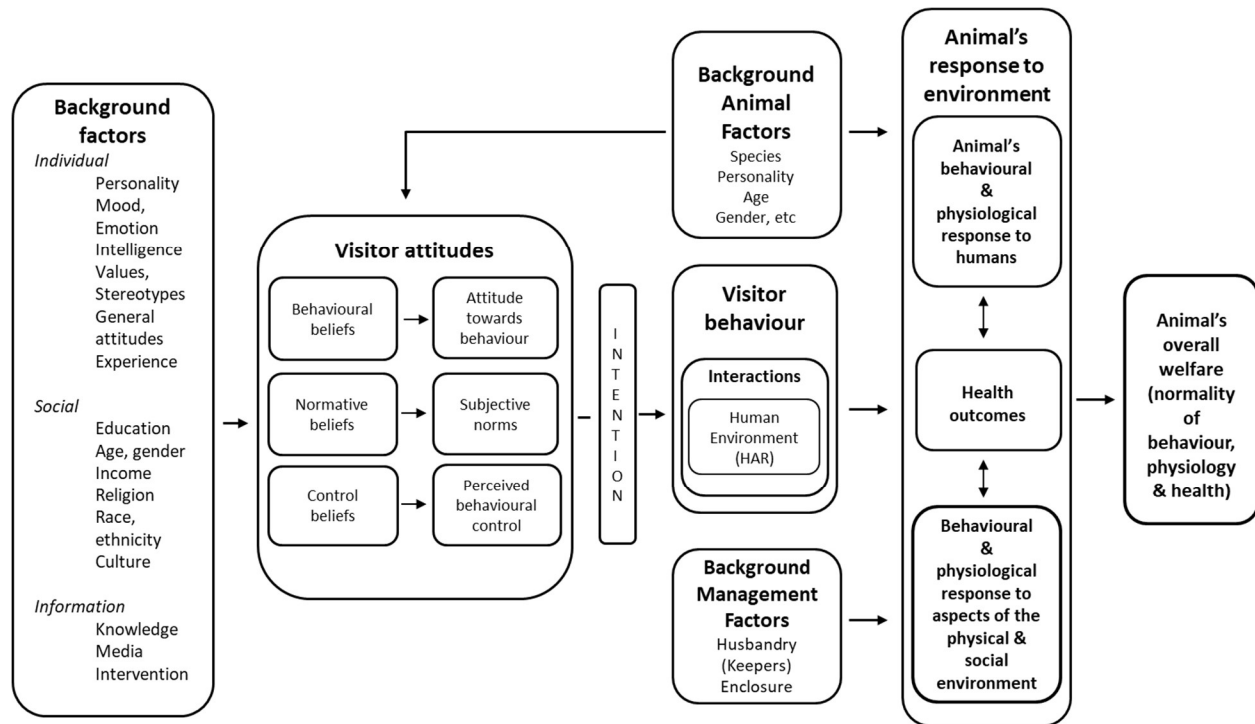


Figure 1.5. Proposed visitor-animal interaction model (adapted from Hemsworth-Coleman model) and obtained from Learmonth (2019).

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Chapter 2

Effects of regulating visitor viewing proximity and the intensity of visitor behaviour on little penguin (*Eudyptula minor*) behaviour and welfare.

This chapter examined the effects of regulating both the viewing proximity of visitors and the intensity of visitor behaviour on little penguin behaviour and stress physiology at Melbourne Zoo (Zoos Victoria, Melbourne, Australia).



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2.1 Simple Summary

Some studies on zoo penguins have shown that the presence of visitors may be fear-provoking. To manage zoo visitor–animal interactions, it is important to determine what it is about visitors that affects zoo penguins. Consequently, we investigated the effects of regulating both zoo visitor viewing proximity to the penguin enclosure and the intensity of visitor behaviour on the behaviour and stress physiology of little penguins. A physical barrier was used to increase visitor viewing distance, by 2 m away from the enclosure, and signage and uniformed personnel was used to attempt to regulate the intensity of visitor behaviour. Signage and uniformed personnel had no effect on visitor number, noise level or visitor behaviour. However, the physical barrier reduced the frequency of potentially threatening visitor behaviours such as banging on enclosure features, looming over the pool, physical contact with the pool's water and sudden movement. When visitors were further away from the enclosure, fewer penguins were huddling, vigilant, and retreating, and more penguins were close to the visitor viewing area, surface swimming and preening in the water. There were no effects of visitor viewing proximity or signage and uniformed personnel on the stress physiology of the little penguins. While there was no effect of signage and uniformed personnel in moderating visitor behaviour, the viewing proximity of visitors to the enclosure affected both visitor and penguin behaviour, where potentially threatening visitor behaviours were decreased, and little penguins showed less avoidance behaviour when visitors were further away.

2.2 Abstract

We examined the effects of regulating the viewing proximity of visitors and the intensity of visitor behaviour on behaviours indicative of fear and stress physiology of 15 zoo-housed little penguins (*Eudyptula minor*). A 2×2 factorial fully randomised design was used to examine the effects of regulating: (1) the viewing proximity of visitors to enclosure, 'normal viewing distance' and 'increased viewing distance' (using a physical barrier set up 2 m away from the enclosure), and (2) the intensity of visitor behaviour, 'unregulated visitor behaviour' and 'regulated visitor behaviour' (using signage and uniformed personnel). In addition, a treatment consisting of closing the enclosure to visitors was included. Penguin behaviour, visitor numbers and visitor behaviour were recorded by CCTV video recordings and direct observations, respectively. Penguin faecal glucocorticoid metabolites were also analysed as a measure of stress physiology. We found that increased viewing distance reduced ($p < 0.05$) all visitor behaviours except for loud vocalisations and tactile contact with penguins. However, there were no direct effects of signage and uniformed personnel on visitor behaviour ($p > 0.05$). As the regulation of viewing proximity increased from a closed exhibit to an open exhibit with increased viewing

distance, and then to an open exhibit with normal viewing distance, this increased the proportion of penguins huddling ($p = 0.0011$), vigilant ($p = 0.0060$) and retreating ($p = 0.00013$) and decreased the proportion of penguins within 1 m of the visitor viewing area ($p = 0.00066$), surface swimming ($p = 0.00091$) and preening in the water ($p = 0.042$). There were also limited effects of regulating visitor behaviour on penguin behaviour. No treatment effects were found on faecal glucocorticoid metabolites ($p > 0.05$). These results indicate that regulating visitor viewing proximity affects penguin behaviours indicative of fear and visitor behaviour. This suggests that close visitor contact can be fear-provoking for little penguins but increasing the distance between visitors and penguins can reduce fear responses of penguins by regulating both viewing proximity and visitor behaviour. However, it is unclear whether these changes in penguin behaviour are due to the increased separation between visitors and penguins and/or specific visitor behaviours associated with close viewing proximity to the enclosure, such as leaning over the enclosure or tactile contact with the pool, which are impeded when visitors are further away.

Keywords: little penguins; visitor-animal interactions; zoos; visitor effect

2.3 Introduction

Understanding human–animal relationships in zoos has been an area of growing importance because of the effects that humans, especially visitors, can have on different zoo species such as non-human primates, big cats, and ungulates, varying from negative, positive, and neutral effects (Hosey 2013). However, the manner in which visitors affect zoo animals remains unclear, especially for a rarely studied taxa such as penguins (Fernandez *et al.* 2009; Hosey 2013). Research on the human–penguin relationship has primarily been conducted on wild penguins, with growing evidence that human contact can negatively affect various wild penguin populations. For example, Adelie penguins (*Pygoscelis adeliae*) have been found to have reduced breeding success as a result of repeated human approaches and nest checks (Giese 1996). Yellow-eyed penguins (*Megadyptes antipodes*) at sites exposed to unregulated tourism have been found to have lower breeding success and fledging weights (McClung *et al.* 2004; Ellenberg *et al.* 2007). Also, sites frequently visited by tourists dramatically increased heart rate and reduced reproductive success of Humboldt penguins (*Spheniscus humboldti*) (Ellenberg *et al.* 2006), and increased vigilance and agonistic behaviours in King (*Aptenodytes patagonicus*), Gentoo (*Pygoscelis papua*) and Royal penguins (*Eudyptes schlegeli*) in response to human approach (Holmes *et al.* 2006; Holmes 2007). Furthermore, when exposed to high levels of human visitation, wild little penguin (*Eudyptula minor*) populations in

Australia increasingly avoid nesting areas (Giling *et al.* 2008). In contrast, some penguin species in the wild have been found to habituate to human contact, depending on previous experience and the amount of exposure to humans (Yorio and Boersma 1990; Fowler 1999; Villanueva *et al.* 2012). Despite the range of research on wild penguins, there is limited research investigating the effects of visitors on zoo-housed penguins.

To our knowledge, there have been only four studies to date that have investigated the effects of visitor presence on zoo-housed penguins. Two of these studies found negative effects of visitors, where one study showed that African penguins (*Spheniscus demersus*) reduced their pond use (Ozella *et al.* 2014), and another study found that little penguins displayed increased aggression, huddling and avoidance behaviours (Sherwen *et al.* 2015b) in response to visitor presence. In contrast, as visitor numbers increased, Humboldt penguins were found to spend more time swimming underwater at the underwater viewing window (Condon *et al.* 2003), and aquarium-housed Gentoo penguins increased their behavioural diversity and pool use (Collins *et al.* 2016). These latter two studies suggest a potential positive effect of visitors. However, results from these four studies need to be interpreted with caution as three of the above-mentioned studies examined correlations between visitor numbers and penguin behaviour (Condon *et al.* 2003; Ozella *et al.* 2014; Collins *et al.* 2016), and only one study was under experimental conditions (Sherwen *et al.* 2015b). Also, this variation in penguin behaviour related to visitor contact may be due to species or individual animal differences, such as past experiences and coping style, enclosure design or the nature of the visitor interactions (Learmonth *et al.* 2018). Consequently, it remains unclear what aspect of visitor contact affects penguin behavioural responses.

In zoos, animals may be exposed to a range of stimuli from visitors including auditory, visual, tactile, olfactory, and vibratory stimuli that may affect an animal's perception of visitors, resulting in different behavioural responses (Fernandez *et al.* 2009; Sherwen *et al.* 2015a). If visitors are perceived as fear-provoking, knowledge about the effects of regulating visitor contact, such as visitor behaviour management to reduce stimuli that animals may perceive as threatening, could be useful in reducing visitor effects on animal fear. Behavioural responses to threats, which may be indicative of fear, in penguins commonly include immobility, retreat or avoidance, vigilance, huddling, reduced preening and aggression (Ainley 1972; Ainley 1974; Eggleton and Siegfried 1979; Holmes *et al.* 2006; Holmes 2007; Hughes *et al.* 2008; Black *et al.* 2016). Meanwhile, the main physiological stress responses to threatening stimuli are via the sympatho-adrenal medullary system and the hypothalamo-pituitary-adrenal (HPA) axis, resulting in the secretion of

catecholamines and glucocorticoids, respectively, when activated (Moberg 2000; Sapolsky 2002). Physiological stress in zoo animals is commonly measured through faecal glucocorticoid metabolite (FGM) concentrations because of its non-invasive sampling technique (Shepherdson *et al.* 2004). Consequently, by utilising both animal behavioural and physiological measures, and experimentally regulating visitor contact, we can identify approaches to manage visitors to reduce their behaviours that may be perceived as fear-provoking for penguins, and consequently improve penguin welfare.

In this study, as a follow-up to Sherwen *et al.* (2015b), we jointly examined the regulation of two aspects of visitor contact on little penguin behaviours indicative of fear and stress physiology: (1) visitor viewing proximity, by regulating how close visitors could approach the enclosure, using physical barriers, and (2) intensity of visitor behaviour, by including visual reminders to visitors for them to reduce noise, startling, and interactive behaviours. We also added a treatment where the exhibit was closed to visitors.

2.4 Materials and Methods

This study received ethical approval from the Zoos Victoria Animal Ethics Committee (approval number ZV15022) and was conducted at the Melbourne Zoo penguin exhibit. It housed a breeding group of 15 little penguins (ten females, five males; aged between 5 months to 13 years) in an outdoor, naturalistic 330 m² enclosure consisting of sand and vegetation areas, and a large swimming pool (from shallow waters near ramps, to a maximum depth of 3m) with current flow throughout the water (Figure 2.1). The exhibit walls were 1.2 m in height and the visitor pathway ran along three sides of the exhibit, with the main penguin viewing positions being along the length of the pool, side A, but opportunities to view penguins also occurred on the short ledge of the pool, side B (Figure 2.1). The penguins were fed twice a day (09:00 and 15:30). Husbandry including the monitoring of animals, cleaning and feeding of penguins, followed normal routines, and remained consistent throughout the course of the study.

2.4.1 Design & Treatments

A 2 × 2 factorial treatment arrangement was used to examine the combined effects of regulating both viewing proximity and the intensity of visitor behaviour on penguins:

1. Viewing proximity of visitors to enclosure at two levels:

- a. *'Increased viewing distance'*—a barrier was set up 2 m from the enclosure to increase the distance between visitors and the enclosure (Figure 2.2). This allowed unrestricted viewing of the enclosure but was a strong impediment to visitors physically interacting with the glass windows of the pool, pool water and other enclosure features.
- b. *'Normal viewing distance'*—no barrier was in place and visitors could approach to the edge of the pool (i.e., visitors could approach within 2 m of the enclosure).

2. Intensity of visitor behaviour at two levels:

- a. *'Unregulated visitor behaviour'*—visitor behaviours were uncontrolled.
- b. *'Regulated visitor behaviour'*—the objective of this treatment was to attempt to reduce the intensity of visitor behaviour using signs requesting visitors to be quiet, move slowly in the exhibit area and avoid physically interacting with the penguins (Figure 2.3). Also, for this treatment, the researcher was dressed in zoo uniform. This procedure has been successfully used in research on meerkats to reduce the intensity of visitor behaviours (Sherwen *et al.* 2014).

In addition to this factorial arrangement, a treatment consisting of closing the enclosure to visitors ('closed exhibit') was included. This fifth treatment can be used to confirm that the presence of visitors increased behaviours indicative of fear in penguins. Alternatively, it can be considered as an extreme level of regulating visitor proximity.

Thus, there were five treatments studied:

1. *Normal viewing distance and unregulated visitor behaviour*—no barrier in place and visitor behaviour was uncontrolled.
2. *Increased viewing distance and unregulated visitor behaviour*—barrier was in place and visitor behaviour was uncontrolled.
3. *Normal viewing distance and regulated visitor behaviour*—no barrier in place and visitor behaviour was attempted to be controlled.
4. *Increased viewing distance and regulated visitor behaviour*—barrier was in place and visitor behaviour was attempted to be controlled.
5. *Closed exhibit*—penguin exhibit closed to the public.

Each treatment was randomly imposed for 2-day periods, two treatments per week with one day break in between (Mon–Tues and Thurs–Fri), with three replicates of each treatment (total of 30 study days) using a fully randomised factorial design.

The study was conducted from the end of February to May 2016 (Summer/Autumn) over 9 weeks, and was only conducted on school working days, to avoid the normal systematic variation in visitor numbers that occurs on weekends and during school holiday periods. Two out of the 9 weeks had treatments with no day break in between. This was due to public holidays occurring on the Monday one week and Friday the other week.

2.4.2 Animal behavioural observations

Four CCTV cameras placed around the enclosure, covering the main areas utilised by the penguins and recording continuously each day, were used to transcribe penguin behaviour at the group level (Figure 2.4). Observations were only conducted on the birds visible on camera.

Penguin behavioural data were transcribed during the playback of the video footage and were overlayed to watch all four cameras on one screen using the VLC Media Player 2.2.1 (Figure 2.4). Observations were conducted on all study days in 3 × 1 h observation blocks (10:00–11:00, 11:30–12:30, 14:00–15:00). A combination of instantaneous point sampling and one-zero sampling was used for behaviour patterns that were considered states (of an appreciable duration) and events (relatively short durations), respectively (Martin and Bateson 2007; see Table 2.1 for a description of these two types of behaviours). Instantaneous point sampling at 3 min intervals was used to record the number of visible penguins in each behavioural state. Furthermore, one-zero sampling every 30 s, within each 3 min interval, was used to record the number of visible penguins performing each of the behavioural events.

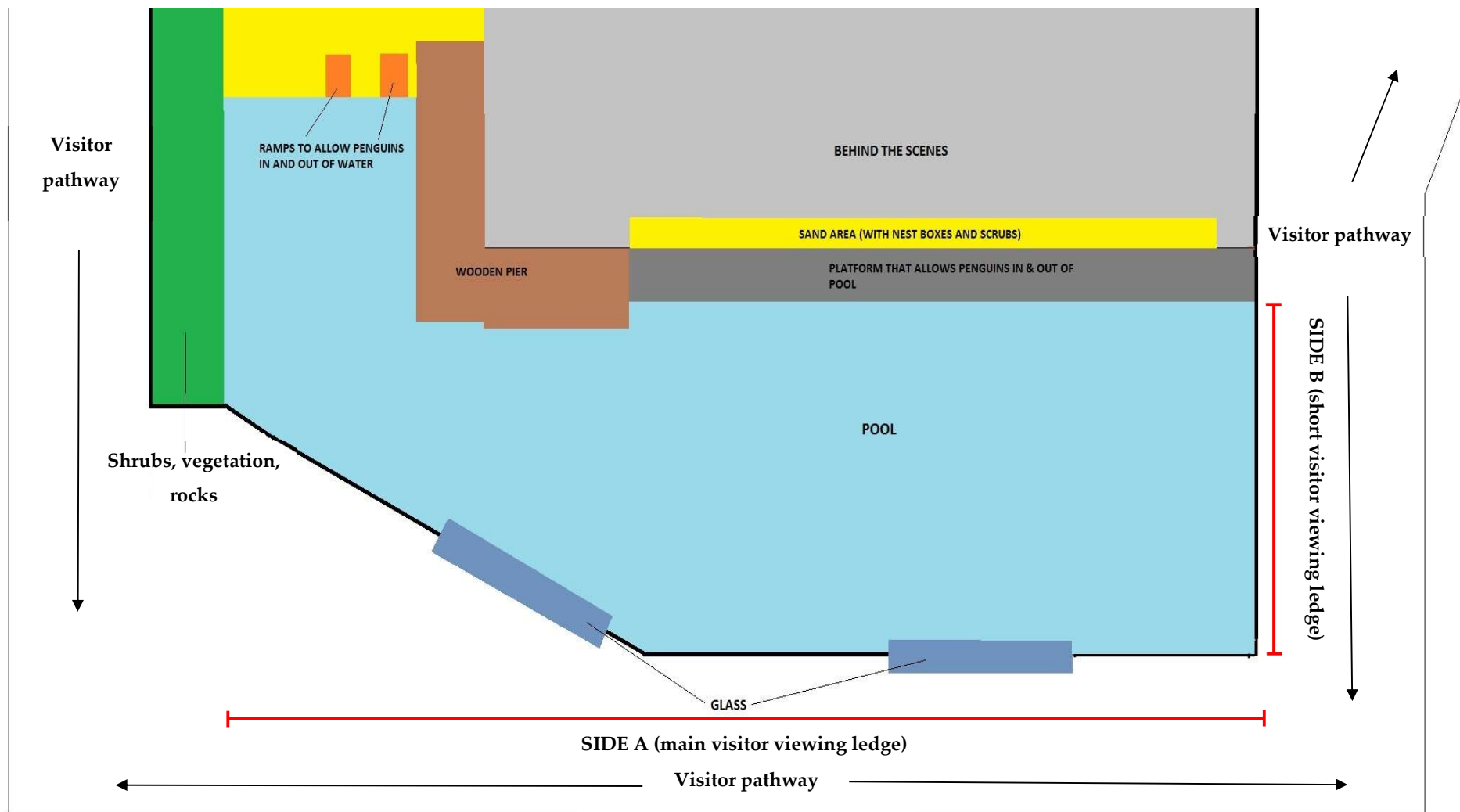


Figure 2.1. Diagram of Melbourne Zoo penguin exhibit. The red star indicates the position of sound level meter.



Figure 2.2. The setup of the barrier in the exhibit area.

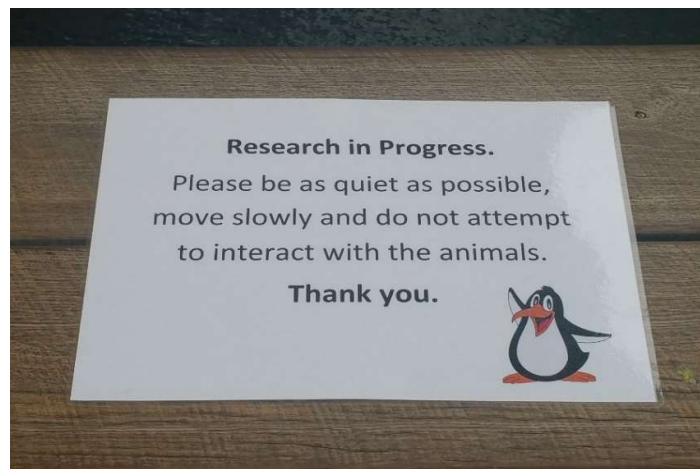


Figure 2.3. Signs used to attempt to regulate visitor behaviour.



(a)



(b)



(c)



(d)

Figure 2.4. The areas studied, captured by the cameras (a). Area 1 – captured the main pool corner of the exhibit where penguins were clearly visible to visitors in this area (the red line indicates where Area 1 ended for observations due to overlap between the cameras for Area 1 and 2) (b). Area 2 – captured the main length of the pool (penguins in this area was clearly visible to visitors), (c). Area 3 – captured the pier and a section of the pool (penguins were clearly visible to visitors in this area) and (d). Area 4 – captured the land area of the exhibit (penguins in this area were either not visible to visitors or partially obstructed by exhibit features including vegetation, wooden barriers, nest boxes).

Table 2.1. Ethogram of penguin behaviour.

Behaviour	Description
<i>States</i>	
Distance from visitor viewing area (m)	Side A: long/main visitor viewing ledge of the exhibit, within <1 m or >1 m of visitor viewing area. Side B: short visitor viewing ledge of the exhibit, within <1 m or >1 m of visitor viewing area.
Huddling (land)	Stationary, positioned within one flipper distance of at least one other penguin.
Resting (land)	Belly on the ground, in a prone position, with eyes open or closed.
Idle (land)	Standing on two feet with a relaxed posture, eyes open or closed; not visually scanning the environment.
Vigilance (land)	Standing on two feet, visually scanning the environment with head movements from left to right or vice versa.
Locomotion (land)	Upright position, moving from one location to another either by walking or running.
Surface swimming	Moving or floating on the surface of the water, with head erect or in the water.
Diving	Swimming under the water surface.
<i>Events</i>	
Preening (on land)	Running bill through plumage on land.
Preening (in water)	On the surface of the water and running bill through plumage.
Allopreening	Running bill through the plumage of another bird(s).
Agonistic interactions (one or a combination of these behaviours)	Peck: Directed at another individual in which an individual directly hits or strikes at another bird with its bill. Bill slap: hit or strike with the side of the bill. Bill joust: an individual interlocks bill with another individual's bill. Lunge: sudden forward thrust of the body towards another individual. Chase: individual runs after another individual.
Flee	Diving or moving rapidly away from current position in response to a direct approach or interaction by human.

Retreat	Swimming or locomoting (on land) slowly away from human approach or presence.
Social interaction	On land: Approaching another individual with flippers back, pushing individual in a circular motion, nibbling and/or preening head or neck of the individual. In water: approaching another individual in the water, in a circular motion, nibbling and/or preening head or neck of the individual.
Manipulating inanimate object	Using bill to peck or nibble at an inanimate object such as a plant, stick, rock, grass, etc.
Chasing insect	Following a flying insect.
Interaction with keeper/staff	Approaching keepers and engaging in play, feeding and/or agonistic behaviours toward keepers.

2.4.3 Penguin faecal sampling and analysis: Faecal glucocorticoid metabolites (FGM)

Faecal samples were collected by the principal investigator (SJC) at the end of the first and second day of each replicate of each treatment between 15:30 and 16:30, and samples were immediately stored in a freezer at -20°C . Samples were collected on both days because previous research on this population has found that the median excretion lag time is 7 h and peaked on average at 10.8 h after a health check (Sherwen and Fanson 2015). However, Sherwen and Fanson (2015) found that three of the four penguins studied showed a peak response 5–7 h after the stressor. Consequently, we would expect that if some individuals on the first day of each replicate of a treatment in our experiment were exposed in the morning to fear-provoking bouts of visitor contact, these stress responses would be reflected in FGM concentrations in samples late in the afternoon. Due to limitations of collection, it was not always possible to identify which faecal samples came from which bird. Therefore, we collected all samples deposited over an hour after their feed with the aim of obtaining a good representation of the whole population. An average of 13 samples (range 7–20) were collected per day for the group of 10–15 birds, for an average of 91% of the penguins sampled each day. When more than one sample was knowingly collected from the same individual on the same day ($n = 17$ samples), the average FGM value for that individual was used. A total of 397 faecal samples were collected during the study. From those samples, 372 samples (96%) were then used to calculate final concentrations for analysis (after samples with a sample coefficient of variation (CV) greater than 20% and sample weights less than 0.01 g were

removed); 83, 82, 74, 73 and 60 samples were collected in treatments 1, 2, 3, 4 and 5, respectively.

Faecal samples were dried in a lyophilizer (TFD series, ilShin Biobase, Amsterdam, Netherlands) at -80°C for 24 h. They were then pounded and sifted to remove debris. One mL of 60% methanol was added to 0.10 g of dried faecal powder in polypropylene tubes. Samples were mixed on a vortex until samples were homogenised (~10 s) and then shaken on an orbital shaker for 1 h then centrifuged for 10 min at 2000 rpm (Hettich Universal 320 R, Tuttlingen, Germany; RCF = 2500). Supernatant was poured into 1.5 mL microcentrifuge tubes and stored in a freezer at -20°C . FGM was measured and analysed using a validated double-antibody cortisone enzyme-immunoassay for little penguins (Sherwen and Fanson 2015). Furthermore, this assay was similar to an assay made by the same manufacturer that has been validated for Adelie penguins (Nakagawa *et al.* 2003; Ninnes *et al.* 2010). Assay procedures have been previously described (Sherwen and Fanson 2015). All samples were assayed in duplicates and data are expressed as ng/g dried faeces for final concentrations. The intra-assay CV was less than 15%. Inter-assay CVs were 4.2% and 9.1% for low and high controls, respectively (n = 11 plates).

2.4.4 Visitor behavioural observations

Visitor observations were directly conducted by the principal investigator (SJC) using instantaneous point sampling at 3 min intervals in seven 30 min blocks between 09:30 and 15:15 to record visitor numbers (number of adults and children within 1 m of enclosure). Within each 3 min interval, the frequency of visitor behavioural events (described in Table 2.2) was recorded continuously in each observation block. These observations were made from the visitor viewing area in the furthest corner of the exhibit area to reduce the effect of researcher presence on the penguins and visitors. Ambient noise level was recorded every 3 min using a sound level data logger (Standard ST-173) which was placed inside the penguin exhibit (Figure 2.1).

Table 2.2. Ethogram of visitor behaviours.

Behaviour	Description
Tactile contact with enclosure features	Tapping or banging on the glass windows, barriers, or enclosure features.
Loud vocalisations	Shouts, screams, loud whistles to attract the animals' attention.
Looming	Leaning on or over the exhibit barriers to view animals in the water or on land. Penguins > 0.5 m—penguins greater than 0.5 m away from looming position. Penguins < 0.5 m—penguins less than 0.5 m away from looming position.
Tactile contact with water	Touching/flicking/slapping the water with the hand(s), which creates ripples in the water.
Tactile contact with penguin	Touching penguin with the hand(s).
Sudden movement	Running, waving, or jumping towards or at the penguin(s) and/or exhibit.

2.4.5 Data Analysis

Measurements were based on the proportion of penguins visible on the video footage and were averaged over the 2-day period treatment to obtain a single summary value for each 2-day period. For animal behavioural states, the proportion of penguins visible per sample point per day was calculated and averaged in order to calculate the proportion of visible penguins observed displaying each behaviour for each day. Animal behavioural events were handled in a similar manner whereby the average proportion of visible birds within each 30 s observation interval per day, observed displaying each behavioural event was calculated. In relation to visitor variables, the numbers of adults and kids were summed to give the visitor number, noise level (dB) was averaged, and visitor behaviours were totalled for each day (the average number of times each behaviour was observed in each of the seven 30 min observation blocks) and subsequently averaged over the 2-day period treatment replicates to obtain a single summary value. FGM was also averaged over samples obtained in the 2-day period treatment replicates to obtain a single summary value. The 2-day summary values were used as the unit of analysis in all statistical analysis.

Preliminary analysis indicated that the strongest observed effects could be considered as an ordered function of the allowed viewing proximity of visitors (normal viewing distance vs. increased viewing distance vs. no visitors (exhibit closed)). Thus, measurements were analysed using a single error analysis of variance (ANOVA) with terms for (i) visitor viewing proximity regulation (normal viewing distance; increased viewing distance; exhibit closed), (ii) visitor behaviour regulation (regulated; unregulated) when exhibit was open and (iii) interaction between visitor viewing proximity and visitor behaviour regulation when exhibit was open. These terms had 2, 1 and 1 degrees of freedom, respectively. No visitor measurements were recorded when the exhibit was closed, since most visitor measurements are, by definition, zero (e.g., when the exhibit is closed there are no visitors, thus the frequency of each visitor behaviour is always zero). Thus, the analysis of visitor measurements was modified to have only 2 levels for the visitor proximity term (normal viewing distance; increased viewing distance). In these cases, the analysis simplified to a 2 by 2 (visitor viewing proximity by visitor behaviour regulation) factorial ANOVA. Prior to statistical analysis, the values for animal behaviour (state and events) were angularly transformed and the values for visitor behavioural events were square root transformed so that the residual variation was similar in all treatments. No transformation was required for FGM.

Meteorological data (maximum and minimum daily temperatures), zoo visitor gate numbers and the proportion of male penguins, all measurements that are unlikely to be affected by the treatment applied, were used as covariates if they were significant ($p < 0.05$). This improved, sometimes substantially, the precision of some of the statistical analyses. The proportion of males was considered as a covariate since by the end of the study only females were exhibited after two males were removed for medical reasons and three males were removed to prevent early breeding.

For visitor data, the p values, of each term, were calculated using the F distribution with 1 or 8 degrees of freedom, except for analyses that included covariates, where an F distribution with 1 or 7 degrees of freedom was used. Some visitor behaviours only occurred with the normal viewing distance, and in these cases p values were calculated using non-parametric permutation tests since the large number of zero values can cause over-sensitivity in the analyses. Also, in these cases, standard errors of difference were calculated from analyses only including normal viewing distances, so as to avoid severe underestimation of these standard errors.

For animal behaviour data and FGM, p values for proximity effects were calculated using the F distribution with 2 or 10 degrees of freedom, except for analyses that included covariates, where an F distribution with 1 or 9 degrees of freedom was

used. For regulation effects and interactions, p values were calculated using the F distribution with 1 or 10 degrees of freedom, except for analyses that included covariates, where an F distribution with 1 or 9 degrees of freedom was used. Analyses were carried out using the ANOVA directive and APERMTEST procedure of GenStat 16th Edition statistical program (software for biosciences).

2.5 Results

2.5.1 Visitor variables

Increased viewing distance (2 m from the enclosure) reduced visitor tactile contact with enclosure features by 90% ($F_{1,8} = 27.71$, $p = 0.00076$), looming behaviour with penguins greater than 0.5 m from looming position by 99.8% ($F_{1,8} = 762.77$, $p = 3.2 \times 10^{-9}$), tactile contact with water by 100% ($F_{1,8} = 104.74$, $p = 0.00054$) and sudden movements by 99% ($F_{1,8} = 8.67$, $p = 0.019$; Table 2.3). However, there was no corresponding effect ($p > 0.05$) on ambient noise, loud vocalisations, looming behaviour with penguins less than 0.5 m from looming position or tactile contact with penguins. Increased viewing distance was also associated with a 30% reduction in the number of visitors to the exhibit ($F_{1,7} = 0.51$, $p = 0.0047$; Table 2.3). There was no evidence at the 5% level that the attempted regulation of visitor behaviour affected actual visitor behaviour, ambient noise, or the number of visitors to the exhibit (Table 2.3). Nevertheless, the best estimate for the effect of the attempted regulation of visitor behaviour is the frequency of tactile contact with enclosure features (the third highest frequency of the recorded behaviours) which was reduced by about 40%, although the p value was 0.30 (Table 2.3).

Table 2.3. Effect of treatment on visitor variables measured. The means shown are the mean frequency of visitor behaviours (per seven 30 min observations blocks per 2-day period) considered as events and ambient noise level per 2-day period. All measurements were square root transformed, except for ambient noise level and the number of visitors (*). Back-transformed means are presented in parentheses.

Visitor variables	Covariate	Open Exhibit					Proximity ^a	<i>p</i> -Value	
		Increased viewing distance		Normal viewing distance		s.e.d. ^c		Regulation effects ^a	Proximity X Regulation
		Regulated	Unregulated	Regulated	Unregulated				
Ambient noise (dB)*	Maximum temperature	62	61	61	62	0.62	0.49	1.00	0.11
Number of visitors*	Visitor gate numbers	360	300	500	460	46	0.0047	0.080	0.77
<i>Behaviour</i>									
Tactile contact with enclosure features		0.91 (0.83)	1.7 (2.8)	5.1 (26)	6.2 (39)	1.18	0.00076	0.30	0.84
Loud vocalisations	Proportion of males	8.5 (73)	9.8 (97)	7.0 (48)	11 (123)	1.87	0.98	0.075	0.33
Looming with penguin > 0.5 m (from looming position)		0.57 (0.32)	1.6 (2.6)	22 (492)	21 (461)	1.06	3.2 × 10⁻⁹	0.82	0.28
Looming with penguin < 0.5 m (from looming position)		0	0	0.86 (0.74)	1.3 (1.6)	0.85 ^d	0.061 ^b	0.64 ^b	0.64 ^b
Tactile contact with water		0	0	3.6 (13)	5.1 (26)	0.85 ^d	0.00054 ^b	0.09 ^b	0.09 ^b
Tactile contact with penguin		0	0	0	0.64 (0.41)	0.36 ^d	0.18 ^b	0.18 ^b	0.18 ^b
Sudden movement		2.0 (4)	1.1 (1)	5.0 (25)	5.0 (25)	1.63	0.019	0.72	0.73

^a *p* values were calculated using F tests based on 1, 7 or 1, 8 degrees of freedom depending on whether a covariate was included in the analysis. *p* values less than 0.05 are in bold. ^b *p* values calculated using permutation test. ^c s.e.d. denotes standard error of difference. ^d sed calculated using residual standard deviation obtained from analysis only using observations with normal viewing distance.

2.5.2 Animal behaviour

2.5.2.1 Behavioural states

As the viewing proximity of visitors (with unregulated visitor behaviour) increased from a closed exhibit to an open exhibit with increased viewing distance, and then to an open exhibit with normal viewing distance, the proportion of penguins huddling increased from 25% to 69% ($F_{2,10} = 14.56, p = 0.0011$), the proportion vigilant increased from 3% to 22% ($F_{2,10} = 8.89, p = 0.0060$), the proportion of penguins within 1 m of side A ($F_{2,10} = 16.63, p = 0.00066$) and B ($F_{2,10} = 11.66, p = 0.0024$) decreased from 28% to 1% and 3%, respectively, and the proportion surface swimming decreased from 39% to 9% ($F_{2,10} = 15.27, p = 0.00091$; Table 2.4). When the exhibit was open, regulating the intensity of visitor behaviour (using signage and uniformed personnel) reduced huddling by about 20% ($F_{1,10} = 15.95, p = 0.0025$) but had no effect on vigilance, proximity to side A or B of the visitor viewing area or swimming (Table 2.4). The proportion of penguins huddling in an open exhibit with regulated behaviour and increased viewing distance (25%) was similar to the proportion huddling when the exhibit was closed to visitors (Table 2.4).

The effect on locomotion appears more problematic; especially considering the s.e.d's were considerably lower than those of other behavioural states (Table 2.4), the significant ($p < 0.05$) effects would disappear if there were similar s.e.d's to other behavioural states, and the fact that it was the only behaviour in which a significant interaction ($p < 0.1$) between visitor viewing distance and regulated visitor behaviour was found. No other effects of regulating visitor behaviour or interactions were found on penguin behaviour ($p > 0.05$; Table 2.4). There were no treatment effects ($p > 0.05$) on the proportion of penguins visible, resting, idle and diving (Table 2.4).

2.5.2.2 Behavioural events

Evidence ($p < 0.05$) of visitor viewing proximity on penguin behavioural events only occurred for preening in the water ($F_{2,10} = 4.44, p = 0.042$) and retreating ($F_{2,9} = 28.56, p = 0.00013$; Table 2.4). The occurrence of retreating was very low when viewing distance was increased (with unregulated visitor behaviour) or when the exhibit was closed (Table 2.4). On the other hand, preening in the water mostly occurred with visitors at increased viewing distance (with unregulated visitor behaviour; Table 2.4). Also, there was some evidence ($p < 0.05$) that regulating visitor behaviour decreased the occurrence of allopreening and pecking regardless of viewing distance (Table 2.4). However, it should be noted that the proportion of penguins engaging in the behavioural events in any 30 s period was, in general, very small.

2.5.2.3 *Little penguin FGM concentrations*

There was no evidence ($p > 0.05$) of any treatment effect on FGM concentrations (Table 2.4).

Table 2.4. Effect of treatment on the mean proportion of visible penguins (%) performing each behaviour (state and event) per 2-day period and stress physiology. Results are the average proportion of visible penguins performing each behaviour. Data were angularly transformed, except for FGM concentrations. Back-transformed means are presented in parentheses.

Behaviour	Covariate	Closed exhibit	Increased viewing distance		Normal viewing distance		s.e.d. ^c	<i>p</i> -Value		
			Regulated	Unregulated	Regulated	Unregulated		Proximity ^a	Regulation when exhibit open ^b	Proximty × regulation interaction
<i>States</i>										
Penguins visible	Visitor gate numbers	40 (41)	37 (36)	43 (46)	36 (35)	39 (40)	3.3	0.77	0.070	0.48
Huddling	-	30 (25)	30 (25)	40 (42)	41 (43)	56 (69)	4.5	0.0011	0.0025	0.50
<1m from side A	-	32 (28)	22 (14)	22 (14)	7 (2)	7 (1)	5.4	0.00066	0.93	0.95
<1m from side B	-	32 (28)	27 (21)	28 (21)	8 (2)	11 (4)	6.4	0.0024	0.69	0.75
Resting	-	18 (10)	24 (17)	19 (11)	19 (10)	24 (16)	4.5	0.70	0.96	0.15
Idle	Maximum temperature	36 (35)	34 (31)	38 (38)	40 (41)	45 (51)	4.2	0.081	0.14	0.91
Locomotion (on land)	Proportion male	15 (7)	15 (7)	15 (7)	19 (11)	12 (5)	1.7	0.85	0.023	0.019
Vigilant	-	10 (3)	19 (10)	19 (11)	25 (17)	28 (22)	4.5	0.0060	0.53	0.60
Surface swimming	-	38 (39)	33 (30)	31 (26)	16 (7)	17 (9)	5.1	0.00091	0.92	0.61
Diving	Proportion male	13 (5)	12 (4)	13 (5)	8 (2)	9 (2)	2.6	0.077	0.69	0.83
<i>Events</i>										
Preen (land)	-	19 (10)	18 (9)	18 (9)	24 (16)	22 (15)	4.2	0.21	0.84	0.83
Preen (water)	-	9 (3)	8 (2)	11 (4)	6 (1)	4 (0.54)	2.4	0.042	0.75	0.27
Allopreen	-	6 (1)	4 (0.54)	8 (2)	6 (1)	8 (2)	1.7	0.57	0.039	0.45
Peck	-	3 (0.31)	2 (0.18)	3 (0.36)	3 (0.33)	5 (0.62)	0.54	0.074	0.014	0.78
Agonistic interactions	-	4 (0.48)	4 (0.39)	4 (0.58)	4 (0.51)	5 (0.74)	0.63	0.47	0.10	0.92
Flee	Proportion of males	2 (0.093)	0.54 (0)	0.13 (0)	2 (0.098)	1 (0.061)	0.77	0.069	0.48	0.98
Retreat	Proportion of males	0.36 (0)	0.17 (0)	0.53 (0)	2 (0.16)	2 (0.14)	0.38	0.00013	0.65	0.39

Social interaction (land)	Proportion of males	3 (0.24)	3 (0.28)	4 (0.37)	2 (0.17)	1 (0.020)	1.1	0.11	0.52	0.23
Social interaction (water)	-	0.73 (0.016)	1 (0.052)	1 (0.035)	0	0.32 (0)	0.96	0.35	0.95	0.69
Manipulate object	-	6 (1)	6 (1)	5 (0.76)	5 (0.74)	3 (0.35)	1.8	0.52	0.41	0.74
Chase Insect	-	1 (0.059)	0.58 (0.010)	1 (0.037)	0.36 (0)	0.32 (0)	0.73	0.29	0.65	0.60
Interaction with keeper	Maximum temperature	0	0.59 (0.011)	0.10 (0)	0.28 (0)	0.67 (0.014)	0.45	0.43	0.67	0.20
<i>Physiology</i>										
FGM concentration (ng/g)	Maximum temperature	1600	1140	1657	1272	1600	284	0.71	0.060	0.67

^a Closed vs Increased viewing distance vs Normal viewing distance. *p* values are calculated using F tests based on 2, 9 or 2, 10 degrees of freedom depending on whether a covariate is included in the analysis. *p* values less than 0.05 are in bold. ^b Calculated F tests for Open exhibit based on 1, 9 or 1, 10 degrees of freedom depending on whether a covariate is included in the analysis. ^c s.e.d. denotes standard error of difference.

2.6 Discussion

The viewing proximity of visitors was the only factor that had a statistically significant effect on visitor behaviour, whereby the 2 m separation (using a physical barrier) between the visitor viewing area and the penguin enclosure decreased the frequency of tactile contact with enclosure features, looming over the enclosure ledge, tactile contact with the pool's water and sudden movement. This indicates that the physical barrier not only regulated visitor viewing proximity but also visitor behaviour. Park *et al.* (2008) supports our results, since they found that a physical fence was a more effective strategy to keep visitors on maintained trails at Acadia National Park, USA, compared to educational signage. Similarly, we found no direct evidence that regulating the intensity of visitor behaviour using signage and uniformed personnel was effective, which was aimed at regulating noise, sudden movement, and interaction with the penguins. These results suggest that signage and uniformed personnel were much less effective in regulating visitor behaviour than regulating viewing proximity. This is consistent with Acevedo-Gutiérrez *et al.* (2011), who found that posted signs were unsuccessful in managing interactions between tourists and seals. In comparison, other studies have found that signs can effectively regulate visitor behaviour (Kratovichil and Schwammer 1997; Sherwen *et al.* 2014). Nevertheless, our findings highlight that physical barriers may be an effective management strategy to manage visitor-penguin interactions in zoos.

The primary objective of our experiment was to identify aspects of visitor contact involved in eliciting behaviours indicative of fear, such as increased avoidance behaviour, huddling and vigilance, in little penguins. The study by Sherwen *et al.* (2015b) found that the presence of visitors was fear-provoking but not specifically what aspect of visitors was responsible for this effect. We found that as the regulation of visitor viewing proximity increased from a closed exhibit to an open exhibit with increased viewing distance, and then to an open exhibit with normal viewing distance, more little penguins were observed huddling and vigilant, and less penguins were observed close to the visitor viewing area and surface swimming. This indicates that the study penguins may have perceived visitors as threatening when in close proximity, with the increased vigilance and huddling behaviour reflecting increased alertness, and the increased distance from the visitor viewing area reflecting avoidance. These results are consistent with Sherwen *et al.* (2015b), who studied the same enclosure but with a different mix of individual little penguins, and studies on wild penguins that have found close human proximity affects their avoidance behaviour. For example, the close proximity of humans to penguin landing sites has been shown to delay the landing times on beaches of Yellow-eyed penguins returning from their daily forage at sea (Wright 1998), elicit avoidance responses in Adelie

(Wilson *et al.* 1991) and Humboldt penguins (Ellenberg *et al.* 2006) and increase heart rates in nesting Gentoo (Nimon *et al.* 1995) and Adelie penguins (Giese 1998). Wild little penguins also prefer to nest further away from visitor paths or areas of high human disturbance (Klomp *et al.* 1991; Weerheim *et al.* 2003). Furthermore, in our experiment, the similarity between the effects of increased viewing distance and the exclusion of visitors from the exhibit suggests that a physical barrier to push visitors 2 m away from the enclosure can closely parallel visitor absence for penguins. Consequently, this provides evidence that a physical barrier may be an effective management strategy that results in reduced fear responses in little penguins.

It should be recognised that the increase in behaviours indicative of fear in little penguins, which was elicited by the close proximity of visitors, may have also been influenced by the opportunity for visitors to perform behaviours such as looming, whereby visitors could lean on or over the enclosure ledge, that may have been fear-provoking. This behaviour was the most frequently recorded visitor behaviour and was eliminated by restricting visitors from closely approaching the enclosure by erecting the barrier 2 m from the enclosure. Looming by visitors was often accompanied by tactile contact with the water and sudden movements towards the enclosure. Thus, looming and these accompanying behaviours by visitors when in close proximity are likely to be perceived by penguins as a predatory threat, similar to how an aerial predator would prey upon little penguins. This is supported by Giese (1998) that found a human standing lower to nesting Adelie penguins' horizon represented less of a threat on the basis of reduced heart rate, compared to a human looming over nesting penguins. Furthermore, little penguins are the smallest species of penguins, that grow to an average height of 30 cm and weigh about 1 kg (Stahel and Gales 1987; Dann *et al.* 1991; Wallis *et al.* 2017). They are commonly predated upon by terrestrial predators such as red foxes (*Vulpes vulpes*), cats (*Felis catus*) (Dann 1992; Wiebkin 2011) and water rats (*Hydromys chrysogaster*) (Preston 2008), aerial predators such as sea eagles (*Haliaeetus* spp.) and large gulls (Stahel and Gales 1987), and aquatic predators such as long-nosed fur seals (*Arctocephalus forsteri*) (Bool *et al.* 2007). It is therefore not surprising that little penguins may perceive visitors as threatening, particularly when close visitor contact may be intense, unpredictable, and possibly unrewarding. In addition to the effects on avoidance behaviour and alertness in little penguins, an interesting finding with the effects of regulating visitor viewing proximity was an increase in the number of birds observed preening in the water when visitors were further away. Sherwen *et al.* (2015b) anecdotally reported that penguins perform increased preening while swimming. Presumably, comfort behaviours such as preening are generally more likely to occur when the animal is not threatened (Mckinney 1965; Ainley 1974; Delius 1988; Zimmerman *et al.* 2011). Furthermore, the deprivation of a presumably highly motivated behaviour such as

swimming is a welfare concern (Dawkins 1988; Jensen and Toates 1993; Dawkins 2004). Wild little penguins spend most of their day(s) foraging out at sea (Stahel and Gales 1987; Camprasse *et al.* 2017). However, in the zoo, penguins do not need to forage as their food is provided to them (Sherwen *et al.* 2015b). Yet not surprisingly, we found the penguins still spent most of their time swimming when visitors were not present or when visitors were further away, suggesting it is a highly motivated behaviour and possibly an indicator of a positive welfare state.

While the present experiment and that of Sherwen *et al.* (2015b) show evidence that the penguins perceived visitors as fear-provoking based on behavioural changes, there are several possible explanations for a lack of treatment effects on FGM in our study. There is an extensive body of evidence demonstrating the importance of both predictability and control in determining the behavioural and physiological effects of aversive stimuli (Seligman and Meyer 1970; Weiss 1970; Weiss 1971). A degree of both predictability of visitor contact and control over visitor contact, by hiding from and avoiding fear-provoking visitor interactions, may have been an effective adaptive response in ameliorating the activation of the HPA axis in the penguins when visitor viewing proximity and behaviour were uncontrolled (i.e., standard zoo conditions) (Boissy 1995; Mobbs *et al.* 2015). Another possibility may be that the study period was insufficient to elicit a measurable change in FGM. Our study exposed penguins to some treatments that should have been less stressful than their normal exposure to zoo visitors, and it may take longer for the HPA axis to lower glucocorticoid production than it does to mount a stress response. Nakagawa *et al.* (2003) found that FGM concentrations for Adelie penguins after an adrenocorticotrophic hormone (ACTH) challenge can take up to 48 h to return to baseline levels. Consequently, a more sustained period of treatment, that is greater than a 2-day period, may be required to demonstrate increased stress arising from uncontrolled visitor contact.

There were limited effects of attempting to regulate the intensity of visitor behaviour, through use of signage and uniformed personnel, on penguin behaviours indicative of fear. While fewer penguins were observed huddling, allopreening and pecking, there were no effects of attempting to regulate visitor behaviour on the number of penguins observed close to the visitor viewing area, surface swimming and vigilant. These limited effects on penguin behaviours are not surprising, since this treatment had no observed effect on reducing visitor behaviours that intuitively may be fear-provoking such as tactile contact with enclosure features, loud vocalisations, looming over the enclosure ledge, physically touching the pool's water, and suddenly moving towards the enclosure. However, there may be a precision issue with our results regarding the regulation of visitor behaviour, as the frequency of tactile contact with enclosure features, loud vocalisations and physical contact with the pool were about halved when signage and uniformed personnel was used. Despite not being

statistically significant, it could explain why there were still some effects of attempting to regulate visitor behaviour on some penguin behaviours which provides evidence that signage and uniformed personnel must have affected some relevant aspect of visitor behaviour. On the other hand, a possible reason that the signage had limited effectiveness is that some of the potentially fear-provoking visitor behaviours were not specifically targeted in the signage. Several studies have shown signs that have clear instructions that target a specific behaviour (Meis and Kashima 2017), justification (Marschall *et al.* 2017) and appeal to visitors' emotions (Kratochvil and Schwammer 1997), are more effective in moderating visitor behaviour. The signs, in our study, requested visitors to be quiet, move slowly and not interact with the penguins in the exhibit area, but there was no mention of avoiding specific behaviours such as looming and tactile contact with the water, which were effectively reduced or eliminated by regulating viewing proximity. Thus, in addition to close proximity per se, these visitor behaviours that are possible when close to the enclosure such as leaning on or over the enclosure ledge and physical contact with the water, may be fear-provoking and may be more effectively managed by using a physical barrier rather than signage. Clearly, further experimentation is required to fully appreciate visitor behaviours that are fear-provoking for penguins.

The decreased number of visitors found when visitor viewing distance was increased suggests a potential reduction in visitor dwell times and possibly reduced visitor viewing experience at the penguin enclosure. This is consistent with Sherwen *et al.* (2015a) who found that reducing the visual contact of capuchins with visitors, by using a one-way visual barrier, reduced visitor numbers. In contrast, Sherwen *et al.* (2014) found no effect of signs on visitor numbers. Further investigation on the effects of manipulating visitor behaviour on visitor experience would be valuable for future focus.

Interestingly, no treatment effects were found on the proportion of penguins visible despite the evidence that visitors may be perceived as threatening for penguins with close visitor contact. Visitor gate numbers was a statistically significant covariate for this behaviour. The more visitors that came through the zoo gates, the less penguins were visible. This suggests that penguins may utilise different behavioural strategies depending on the type of visitor contact. For example, high numbers of visitors in the zoo would increase noise levels, but not direct interactive behaviours that would occur at the exhibit. It would be valuable to further investigate this relationship.

2.7 Conclusions

This study provides evidence that regulating the viewing proximity of visitors, either by the installation of a physical barrier or by closing the exhibit to visitors, strongly reduces little penguin behaviours indicative of fear and strongly increases swimming, which is likely impeded by fear. Regulating visitor behaviour by signage was much less effective in changing penguin behaviour, but it is unknown to what extent this was caused by having signage that insufficiently targeted specific visitor behaviours. Regulating visitor viewing proximity or visitor behaviour did not affect little penguin FGM, which may suggest that penguin behavioural responses such as avoidance may have been an effective adaptive response in ameliorating stress arising from close visitor contact, or that the treatment period was insufficient to elicit a measurable change in FGM. However, whether it is visitors being further away per se and/or the reduction of some visitor behaviours such as leaning over the enclosure or tactile contact with the pool that are impeded when visitors are further away, remains unclear.

Author Contributions: S.J.C., P.H.H., S.L.S., G.J.C. and K.L.B. designed the study. S.J.C. was responsible for liaising with the Wild Seas keeping team at Melbourne Zoo (Zoos Victoria) and all other staff and students from the Animal Welfare Science Centre and organising and carrying out the data collection. K.L. Butler aided S.J.C. with the statistical analysis of the data. S.J.C. collected and prepared all faecal samples for analysis, with the help and guidance from K.V.F., who prepared all double-antibody cortisone enzyme-immunoassay plates for analysis and aided in the analysis and interpretations of the physiological data; S.J.C. and P.H.H. wrote the paper; P.H.H., S.L.S., G.J.C., K.L.B. and K.V.F. contributed with feedback and additions to the paper.

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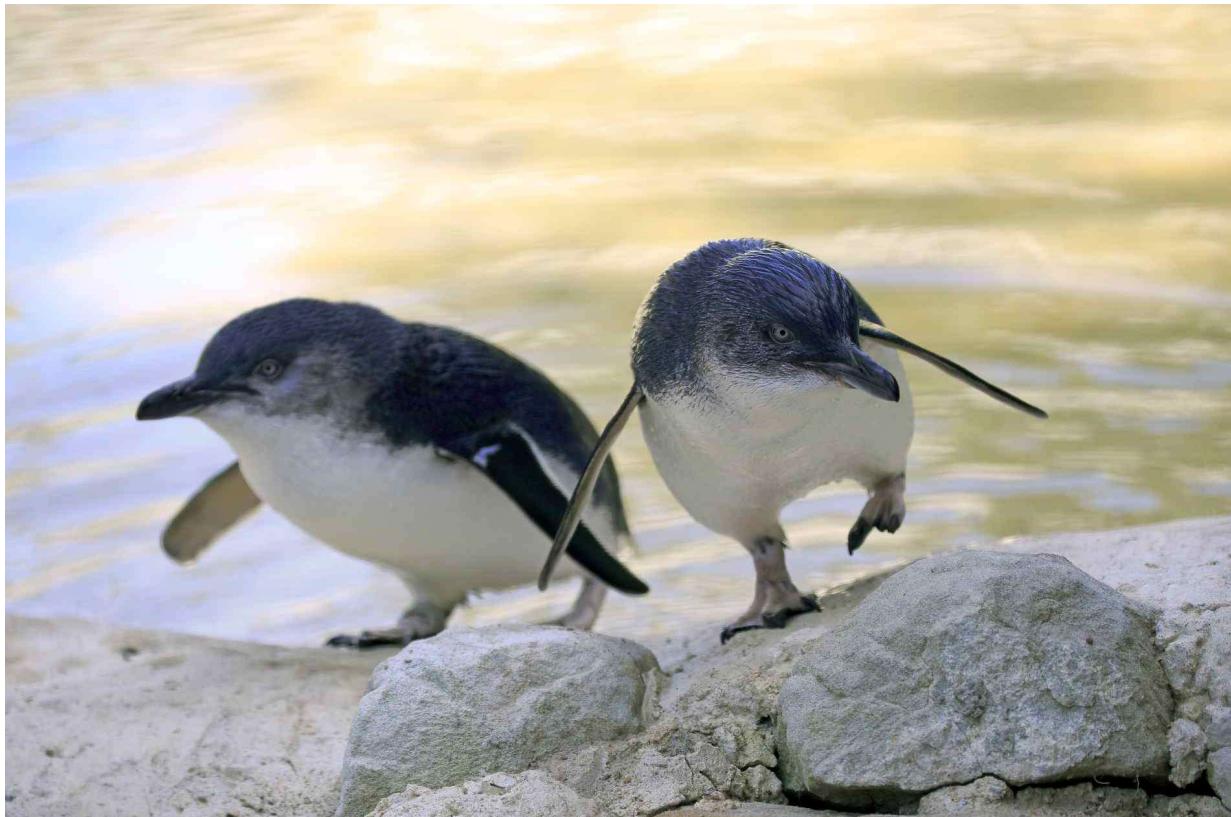
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Chapter 3

Effect of Covering a Visitor Viewing Area Window on the Behaviour of Zoo-Housed Little Penguins (*Eudyptula Minor*)

This chapter presents results on the effect of covering a single visitor viewing area window on little penguin behaviour at Taronga Zoo (Taronga Conservation Society, Sydney, Australia).



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3.1 Simple Summary

Penguins are a common zoo-housed species and have been shown to display behaviours indicative of fear such as huddling, vigilance and avoidance towards zoo visitors. However, this evidence has been obtained from a single public zoo in Melbourne, Australia. Therefore, we investigated the effect of covering a visitor viewing area window on fear behaviour of zoo-housed little penguins at another zoo in Sydney, Australia. Covering one out of four visitor viewing area windows reduced the number of visitors and the occurrence of potentially threatening visitor behaviours at this window such as banging on the window, loud vocalisations, and sudden movement. When the viewing window was covered, the number of penguins visible and preening in the water increased and the number of penguins vigilant near this viewing window reduced. Also, the adjacent corner area, which was not visible to visitors, was found to be a preferred area for the penguins whether the viewing window was uncovered or covered. While there were limited effects, the reduced presence, reduced preening in the water and increased vigilance by penguins near the viewing window when this window was uncovered, together with the general preference for the corner area, provides evidence of some avoidance of visitors. These results suggest that visual contact with visitors and/or other types of visitor contact, such as visitor-induced sounds and vibrations, may be fear-provoking for zoo-housed little penguins. Therefore, these results suggest that penguins in zoos may benefit from modifications to the enclosure that may ameliorate penguin fear responses to visitors such as one-way viewing glass, barriers reducing close visitor contact and areas for penguins to retreat.

3.2 Abstract

Studies on the effects of visitors on zoo animals have shown mixed findings and as a result, the manner in which visitors affect zoo animals remains unclear for many species, including a rarely studied taxa such as penguins. Penguins are a common zoo-housed species and have been shown to display huddling, vigilance and avoidance towards zoo visitors which can be indicative of fear. Here, we examined the effects of covering one visitor viewing area window, out of four, on little penguin (*Eudyptula minor*) behaviours that may be indicative of fear. Two treatments were randomly imposed on different days: 1) The main visitor viewing area window, where most visitor-penguin interactions occurred, was uncovered ('Main window uncovered') and 2) The main visitor viewing area window was covered ('Main window covered'). Penguin numbers and behaviour were recorded near the main visitor viewing area window and the three other visitor

viewing area windows, as well as one area not visible to visitors ('Corner' area). Furthermore, visitor numbers and visitor behaviour were recorded at all four visitor viewing area windows. Covering the main visitor viewing area window reduced the proportion of visitors present at this window by about 85% ($p < 0.001$) and reduced potentially threatening visitor behaviours at this window such as tactile contact with the window, loud vocalisations, and sudden movement ($p < 0.05$). When the main visitor viewing area window was covered, the proportion of penguins present increased by about 25% ($p < 0.05$), the proportion of visible penguins preening in the water increased by about 180% ($p < 0.05$) and the proportion of visible penguins vigilant decreased by about 70% ($p < 0.05$) in the area near this main window. A preference for the Corner area was also found whereby 59% and 49% of penguins were present in this area when the main window was uncovered and covered, respectively. These results provide limited evidence that the little penguins in this exhibit showed an aversion to the area near the main visitor viewing area window when it was uncovered based on the increased avoidance and vigilance and decreased preening in the water in this area. This suggests visitors may be fear-provoking for these little penguins. However, it is unclear whether visual contact with visitors *per se* or other aspects of visitor contact, such as visitor-induced sounds and vibrations, were responsible for this apparent aversion when this window was uncovered.

Keywords: little penguins; visitor-animal interactions; visual contact; zoos; visitor effect; visitor behaviour

3.3 Introduction

Research on the effect of visitors on zoo animals has expanded significantly in the past several years, providing increasing evidence of the various effects visitors can have on a range of zoo species (Sherwen and Hemsworth 2019). However, the literature presents mixed findings, possibly because of a number of factors that may affect the response of zoo animals to visitors such as species-specific differences, individual animal characteristics, enclosure design and the nature and intensity of visitor-animal interactions (Hosey 2013; Sherwen and Hemsworth 2019). As a result, the manner in which visitors affect zoo animals still remains unclear for many species, especially for a rarely studied taxa such as penguins (Chiew *et al.* 2019a). Understanding the way visitors affect zoo animals is important because visitor contact can be unpredictable and intense, with zoo animals being exposed to a range of stimuli from visitors including auditory,

visual, tactile, olfactory, and vibratory stimuli (Fernandez *et al.* 2009; Sherwen and Hemsworth 2019). These visitor stimuli may be perceived by zoo animals as, for example threatening or stimulating, and so understanding this can help identify characteristics of visitors, animals and/or enclosures that affect the nature of visitor contact and be subsequently managed accordingly by zoos (Chiew *et al.* 2019a; Sherwen and Hemsworth 2019). Furthermore, it is important for zoos to also understand how zoo animals affect visitors as there is growing evidence to show that zoo animals, particularly their behaviour, can affect visitor attitudes, behaviour, and experience as well as zoo conservation efforts (Margulis *et al.* 2003; Miller 2012; Godinez *et al.* 2013; Chiew *et al.* 2019b; Godinez and Fernandez 2019). Consequently, understanding zoo visitor-animal interactions has never been more pertinent.

Limited research has been conducted to examine the effects of visitors on zoo-housed penguins despite penguins being a commonly housed zoo species, especially little penguins (*Eudyptula minor*) in Australian zoos (Condon *et al.* 2003; Hosey 2008; Ozella *et al.* 2014; Sherwen *et al.* 2015b; Collins *et al.* 2016; Ozella *et al.* 2017; Chiew *et al.* 2019a). From the limited number of studies that have investigated the zoo visitor-penguin relationship, only two studies at Melbourne Zoo (Australia) have been conducted under experimental conditions (Sherwen *et al.* 2015b; Chiew *et al.* 2019a). The presence of visitors has been found to be fear-provoking for little penguins as indicated by an increased vigilance, huddling and avoidance of the visitor viewing area and reductions in swimming (Sherwen *et al.* 2015b). More recently, Chiew *et al.* (2019a) identified that it is the close viewing proximity of visitors that increased vigilance, huddling and avoidance of the visitor viewing area and decreased surface swimming in little penguins. These two experiments indicate visual contact with visitors may be fear-provoking for little penguins in zoos but, if the aversion and thus perception of visitors as threatening to little penguins is reduced, this can have beneficial effects on penguin welfare. Possible practical ways this can be achieved is through the use of one-way visual barriers or barriers that prevent visitors getting close to the enclosure which minimises the perceived close proximity of visitors and thus, fear of visitors in penguins (Chiew *et al.* 2019a).

Good vision is important for all penguin species as they are visual predators that rely on their vision to find and catch prey underwater and avoid predators (Stahel and Gales 1987; Dann 1992; Bool *et al.* 2007; Preston 2008; Wiebkin 2011; Rodriguez *et al.* 2016). Therefore, visual contact maybe a key component in penguin responses to zoo visitors. This can be tested by manipulating the animal's visual contact with visitors. Only a handful of studies on zoo-housed nonhuman primates have investigated the effects of manipulating visual contact between zoo animals and visitors. For example, reducing

visual contact with visitors by using camouflage netting or one-way vision screens has been found to reduced intragroup aggression and stereotypic behaviours such as repetitive teeth clenching, body rocking, pacing and self-scratching in Western lowland gorilla (*Gorilla gorilla gorilla*) and Black-capped capuchins (*Sapajus apella*) (Blaney and Wells 2004; Clark *et al.* 2012; Sherwen *et al.* 2015a). In contrast, Bloomfield *et al.* (2015) found that when half of the visitor viewing window was covered with a visual barrier and the other half was left open, orangutans (*Pongo pygmaeus abelii*) showed a preference to position themselves in front of the open visitor viewing window which suggests orangutans are visually stimulated by visitors. These studies indicate the effects of visual contact with visitors can vary between species of nonhuman primates but also show that other forms of visitor contact may have been altered by the visual barriers such as visitor behaviour. While this has yet to be examined in zoo-housed penguins, these studies have highlighted some practical ways visitor-animal interactions can be regulated to identify and understand the way visitors affect penguin behavioural responses in zoos.

There is also some evidence in the wild penguin literature that suggests that penguins of the same species at different sites can be affected by humans in a similar manner. For example, Adélie penguins (*Pygoscelis adeliae*) (Culik *et al.* 1990; Wilson *et al.* 1991; Woehler *et al.* 1994; Culik and Wilson 1995; Giese 1996); African penguins (*Spheniscus demersus*) (Hockey and Hallinan 1981; van Heezik and Seddon 1990; Nimon *et al.* 1996), and little penguins (Klomp *et al.* 1991; Weerheim *et al.* 2003; Giling *et al.* 2008; Carroll *et al.* 2016) have consistently shown, at various breeding sites, that human disturbances such as human approach and unregulated tourism (i.e., visitor numbers, noise, behaviour and interactions with penguins were uncontrolled) increase heart rates and avoidance of nesting near visitor footpaths and reduce breeding success. In contrast, wild Yellow-eyed penguins (*Megadyptes antipodes*) at different colony sites vary in their response to human disturbances. For example, at some colony sites unregulated tourism reduced reproductive rates, increased corticosterone concentrations and delayed landing times (Wright 1998; McClung *et al.* 2004; Ellenberg *et al.* 2007), while no effects on breeding success, heart rate and avoidance behaviour were found at other colony sties (Ratz and Thompson 1999; Ellenberg *et al.* 2009). These studies on both wild and zoo penguins highlight the importance of understanding the effect of visitors on the same species of penguins at different zoo sites as there may be similarities or variation in their responses which may be a result of the differing nature of visitor contact that occurs because of different environment characteristics.

The present experiment at Taronga Zoo (New South Wales, Australia) examined the effects of covering one out of four visitor viewing area windows, using a visual barrier,

on little penguin behaviours indicative of fear such as avoidance, huddling and vigilance. It was hypothesised that covering the main visitor viewing area window, where most visitor-penguin interactions occurred, would minimise little penguin fear responses toward visitors. It is recognized that other forms of visitor contact may be affected by the visual barrier such as visitor-induced sounds and vibrations.

3.4 Materials and Methods

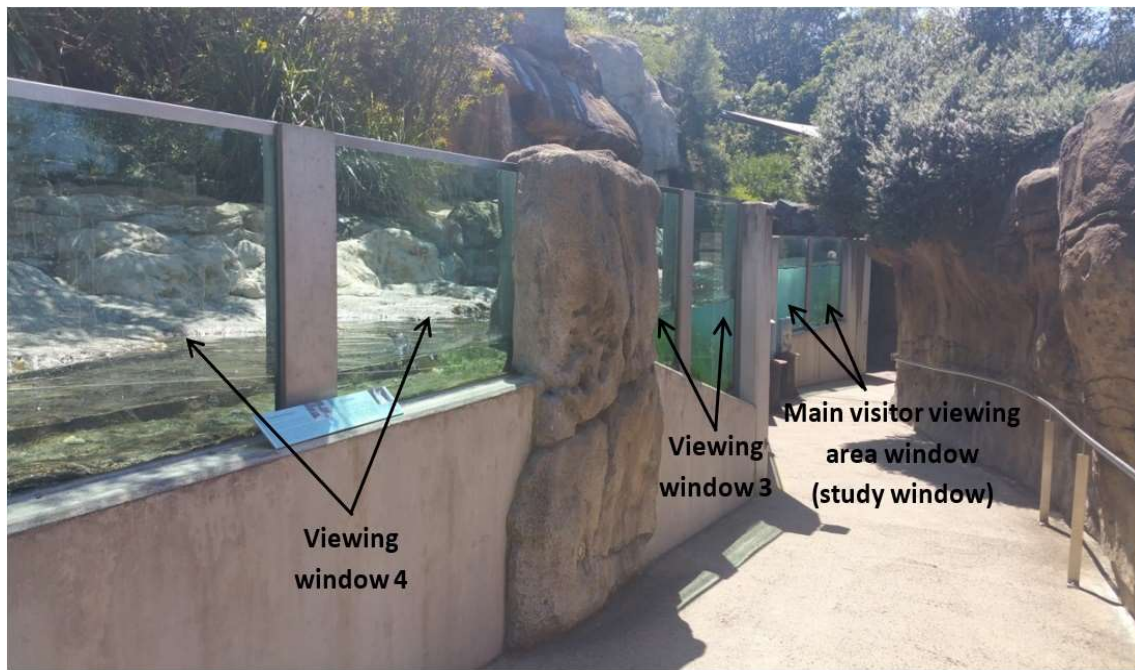
3.4.1 Study Species, Housing and Husbandry

This experiment was approved by the Taronga Conservation Society Australia's Animal Ethics Committee (approval number 3b/02/17) and was conducted at the Taronga Zoo's Great Southern Oceans penguin exhibit during March 2017. Little penguins were housed in an outdoor, naturalistic exhibit that consisted of two sections: the main section where 39 adult little penguins were located (breeding group) and the encounter section which contained 13 individuals (nine females and four males; a mix of juveniles and adults aged between 1 to 5 years old) that were involved in daily close-up encounters with visitors (Figure 3.1). These two sections were adjacent to each other and were separated by a meshed water gate that allowed the penguins in the two groups to have visual contact with one another when in the pool but, had no access to each other.

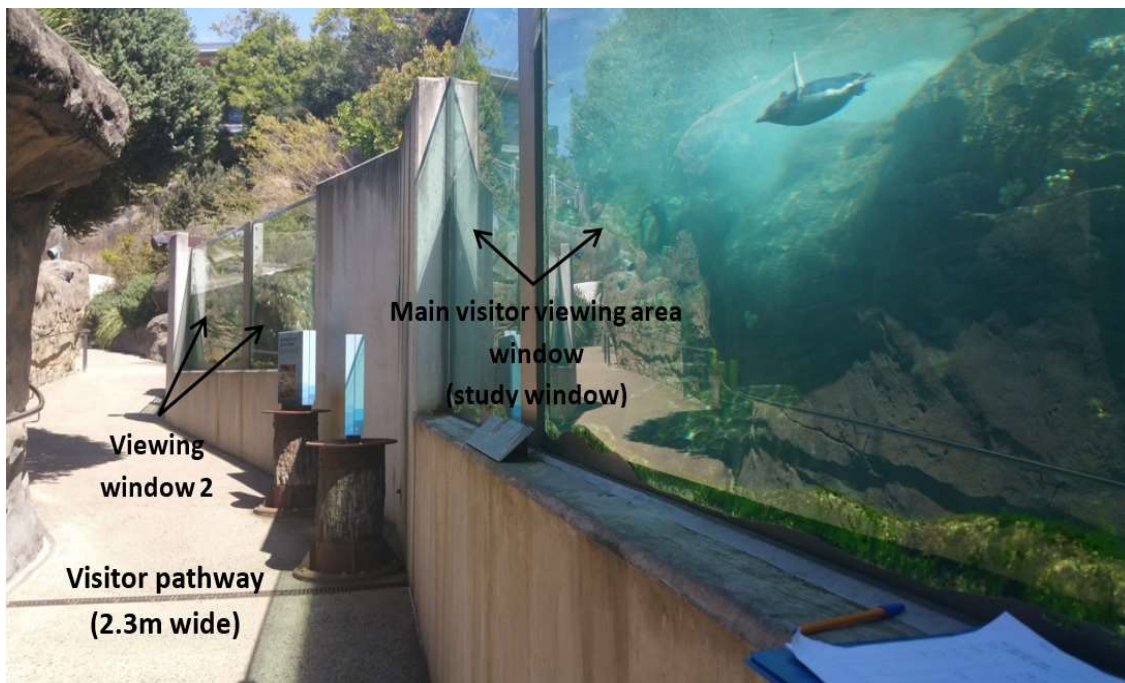
The encounter penguins were the focus of our experiment as they were identified, through preliminary observations, to be the penguins that visitors stopped to view and interact with the most (Figure 3.2). Between the 10th–15th March 2017, there were a total of 14 little penguins in the encounter section of the exhibit as a new male penguin was introduced into the group. However, this penguin was not eating while in this section and was removed on the 16th March 2017. The encounter penguins were fed twice a day, at approximately 09:00 and 14:00 h, where the 14:00 h feed time was when a close-up encounter with visitors occurred. This involved a maximum of four visitors in the exhibit feeding the penguins with a keeper present. The duration of each encounter was approximately 20–25 min and occurred consistently throughout the study period.



Figure 3.1. The Great Southern Oceans penguin exhibit at Taronga Zoo. Focus area was the ‘Encounter section’ of the exhibit (long, skinny pool section in the above figure) where the little penguins involved in close-up encounters were located. The main breeding group of little penguins were located adjacent to this section (i.e., underneath the white sail). The two groups had no access to each other.



(a)



(b)

Figure 3.2. (a). The outdoor encounter section of the penguin exhibit that consisted of four two-pane glass visitor viewing area windows (respectively labelled Main visitor viewing area window and Viewing window 2, 3 and 4) and a visitor pathway that slopes down to an underground viewing area of the main breeding group of penguins. **(b).** The main visitor viewing area window and Viewing window 2 of the encounter section of the penguin exhibit where the main visitor viewing area window was our study window.

The encounter section of the exhibit was 28 m in length and 2.7 m wide at the narrowest end (where keepers entered/exited the exhibit) to 6.5 m wide at the widest end. It consisted of a 26 m length pool that was long and narrow (1 m wide at narrowest point, 4.3 m at widest point) and went from shallow (0.2 m) to deep water (1.6 m; Figure 3.2). The visitor pathway (21 m in length, 2.3 m wide) ran along one side of the exhibit, with viewing positions being along the length of the pool (Figure 3.2). The visitor viewing area of the encounter section of the exhibit consisted of four two-pane glass viewing windows (1.8 m in height) where visitors were able to view the penguins, with the last two glass viewing windows (i.e., Viewing window 3 and 4) having visibility of land areas consisting of sand and vegetation (Figure 3.2).

Husbandry, including monitoring, cleaning, and feeding of penguins followed normal routines and remained consistent throughout the course of the experiment. Both the breeding group of adult penguins and the encounter penguins were not breeding during the study period, and moulting was completed prior to the study period.

3.4.2 Design & Treatments

We used a fully randomised design, in which two treatments were imposed:

1. Main window uncovered – the visitor viewing area window where most visitor-penguin interactions occurred (the ‘Main visitor viewing area window’), determined by preliminary observations, was unaltered so that a normal view between visitors and penguins was provided. This window was adjacent to the area in which penguins spent most of their time, the deep corner area of the pool (i.e., ‘Corner’; Figure 3.1).
2. Main window covered – a visual barrier, made up of eight corflute (corrugated polypropylene) panels, was placed on the main visitor viewing area window and eliminated all contact between penguins and visitors at this window (Figures 3.2 and 3.3).



Figure 3.3. The visual barrier used to block contact between visitors and penguins at the main visitor viewing area window.

Each treatment was randomly imposed for 1-day periods, with 5-replicates of each treatment (total of 10 study days) over 2 weeks. One-day periods were selected because Sherwen *et al.* (2015b) found significant changes in penguin behaviour when treatments were imposed for 1-day periods. To allow the penguins to acclimatise to the visual barrier, it was placed on the main visitor viewing area window the afternoon before the scheduled treatment day. The experiment was conducted from the 6th to 20th March 2017 (Autumn) on school-working days, to avoid the normal systematic variation in visitor numbers that occurs on weekends and school holidays.

3.4.3 Animal Behavioural Observations

Five GoPro cameras (Hero 3, GoPro, Inc. San Mateo, CA, USA) were placed around the exhibit which covered five main areas of the enclosure utilised by the penguins and continuously recorded penguin behaviour between 09:30–15:15 h. These areas were

adjacent to each other and were labelled: 'Corner', 'Main visitor viewing area window'; 'Viewing window 2'; 'Viewing window 3'; and 'Viewing window 4' (Figures 3.4 and 3.5). These areas included both parts of land and pool except for the Corner area which consisted of only the pool with no land areas. Keepers entered and exited at the Viewing window 4 end of the exhibit which was where the penguins were also fed on land (Figure 3.5). Also, the Corner area which was on the opposite end to Viewing window 4, was located at the deep end of the pool beyond the main visitor viewing area window and, was not visible to visitors (all other areas were visible to visitors) whether the visual barrier was in place or not (Figure 3.1).

The main visitor viewing area window was the window that was manipulated in this experiment using a visual barrier (Figures 3.1–3.3). Cameras were positioned to capture the field of view from the visitor viewing area windows (Figures 3.4 and 3.5). Footage from these areas were used to transcribed penguin behaviour using the VLC Media Player 2.2.1. Observations were only conducted on penguins visible in the field of view of the cameras and individual penguin identity was not recorded because individuals were not easily identifiable.

Observations were conducted on all study days in 3×1 h observation blocks and 1×30 min block (10:00–11:00, 11:00–12:00, 12:30–13:30, 14:45–15:15 h), using a combination of instantaneous point sampling for behavioural states and one-zero sampling for behavioural events. It should be noted that the close-up feeding encounter occurred consistently throughout the study period and the fourth observation block was conducted at least 20 min after the encounter to avoid any immediate effects of the encounter on penguin behaviour. Instantaneous point sampling at 3 min intervals was used to record the behavioural states of penguins present in each area and one-zero sampling for 30 s periods, within each 3 min interval, was used to record the number of penguins performing each of the behavioural events (described in Table 3.1).



(a)



(b)



(c)

Figure 3.4. Camera fields of view (a). 'Corner' area (not visible to visitors); (b). 'Main visitor viewing area window' area (above water); (c). 'Main visitor viewing area window' area (underwater).



(a)



(b)

Figure 3.5. Camera fields of view **(a)**. Viewing window 2 and 3 areas; **(b)**. ‘Viewing window 4’ area (where keepers entered and exited).

Table 3.1. Ethogram of penguin behaviour. Adapted from Chiew *et al.* (2019a).

Behaviour	Description
<i>States</i>	
Penguins visible	Penguins present in the field of view of the camera(s).
Huddling (land)	Stationary, positioned within one flipper distance of at least one other penguin.
Resting (land)	Belly on the ground, in a prone position, with eyes open or closed.
Idle (land)	Standing on two feet with a relaxed posture, eyes open or closed; not visually scanning the environment.
Locomotion (land)	Upright position, moving from one location to another either by walking or running.
Vigilance (land)	Standing on two feet, visually scanning the environment with head movements from left to right or vice versa.
Surface swimming	Moving or floating on the surface of the water, with head erect or in the water.
Diving	Locomoting under water surface.
<i>Events</i>	
Preening (on land)	Standing upright on two feet, running bill through plumage.
Preening (in water)	On the surface of the water and running bill through plumage.
Allopreening	Running bill through the plumage of another bird(s).
Porpoise	Continuous swimming in rhythmic serial leaps where the whole-body leaps in and out of the water's surface repeatedly.
Fast swimming	Sudden, rapid movement under water.
Agonistic interactions (one or a combination of these behaviours)	Peck: Directed at another individual in which an individual directly hits or strikes at another bird with its bill.
	Bill slap: hit or strike with the side of the bill.
	Bill joust: an individual interlocks bill with another individual's bill.
	Lunge: sudden forward thrust of the body towards another individual.
	Chase: an individual runs or swims after another individual.

Interaction with glass	Head orientated towards the glass window, either pecking with bill and/or swimming directly at the glass window.
Manipulate object	Using bill to peck or nibble an inanimate object(s) such as rocks, vegetation (e.g., straw or grass) or camera case.
Bathing	In the water, twisting body from side to side in a shaking motion.
Other	Any other behaviour not described above e.g., flapping one or both wings, chasing insect.

These sampling techniques were chosen as they have been effectively used in a previous study (Martin and Bateson 2007; Chiew *et al.* 2019a). It should be noted that the Corner area was the only location in the exhibit where there was no land area on the other side of the pool for the penguins (Figures 3.1 and 3.4). All behaviours were mutually exclusive from one another with the exception of 'penguins visible' and 'huddling (land)' (Table 3.1).

3.4.4 Visitor Behavioural Observations

Visitor observations were conducted directly by the principal investigator (SJC) between 09:30–15:15 h in six 30 min observation blocks. Ambient noise level (dB) in the visitor viewing area was logged continuously, using the Mint Muse Sound Meter Pro iPhone app (Mint Muse, Inc., San Diego, CA, USA) at the enclosure in the same observation blocks from the visitor viewing area. Instantaneous point sampling at 3 min intervals was used to record visitor number (number of adults and children) at each of the four visitor viewing area windows. One-zero sampling for 60 s periods, within each 3 min interval, was used to record visitor behaviour (described in Table 3.2). This was chosen for practical reasons and previous studies that have investigated the dwell time of visitors at various zoo animal exhibits, found that while there were differences between species, the overall average dwell time for visitors was 30 s when animals were inactive and 60 s when animals were active (Bitgood *et al.* 1988; Johnston 1998). These observations were made from the top of the visitor viewing area (pass Viewing window 4), to reduce the effect of researcher presence on the penguins.

Table 3.2. Ethogram of visitor behaviours adapted from Chiew *et al.* (2019a).

Behaviour	Description
Tactile contact with glass windows	Tapping or banging on the glass viewing windows using hands or fingers.
Loud vocalisations	Shouts, screams, loud whistles to attract animals' attention.
Sudden movement	Running, waving, or jumping towards or at the penguin(s) and/or exhibit.
Interaction with a penguin(s)	Interacting with a penguin(s) whereby the penguin(s) is following visitor hand movements or presence.
On enclosure ledge	Standing, sitting and/or climbing on enclosure ledge. May or may not be leaning against the glass visitor viewing window(s).
Passively observing	Standing back, quiet/silent while looking at penguin enclosure. No sudden movements.
Other	Any behaviour not described above e.g., copying penguin vocalisations and flash photography.

3.4.5 Statistical Analysis

Each study measurement was calculated as a summary value for each study day to obtain 5 replicate values of each of the two treatments. On each day, the proportion of penguins visible in each area was calculated at each sample point (= number of penguins visible in the area ÷ the number of penguins in the exhibit on that day). These values were averaged over sample points to provide a daily value for the proportion of penguins visible in each area. On each day, the proportion of visible penguins that were displaying a behavioural state in an area was calculated for each sample point (= number of visible penguins in area displaying behavioural state ÷ the total number of visible penguins) and then averaged over the day. Animal behavioural events were handled in a similar manner whereby the proportion of visible penguins displaying each behavioural event in an area within a 30 s period was recorded, and then averaged over each 30 s period in a day. In relation to visitor variables, for each day, the total number of visitors (all ages) observed at the enclosure was calculated by summing the number of visitors at each viewing area window during the six observation blocks. The proportion of the observed visitors at each visitor viewing area window was calculated from these totals. Average ambient noise level (dB) was calculated from the daily trace. The daily visitor behaviour proportions were calculated by summing the number of 60 s periods that each visitor behaviour

occurred for each day divided by the total number of 60 s periods per day (i.e., 180) to obtain a single summary value.

Prior to statistical analysis, on each day, the summary values for animal behaviour (state and events), the proportion of visitors at each viewing window and visitor behavioural events were angularly transformed, and the daily values for the number of visitors at the enclosure were square root transformed. This ensured that the residual variation was similar in all treatments, and the distribution of residuals had minimal skewness. No transformation was required for ambient noise level.

All measurements were analysed as a two-treatment analysis of variance (ANOVA) for a fully randomised design (equivalent to an unpaired two-sided t-test), using the daily summary values as the unit of analysis. With the exception of 'ambient noise level', this resulted in an analysis with eight residual degrees of freedom. The analysis of variance for 'ambient noise level' had seven residual degrees of freedom because on one day the ambient noise level data was unavailable due to a technical issue. Non-parametric permutation tests, based on the treatment effect F-values, were used for some visitor and animal behaviour measures due to the large number of zero values for some behaviours, which can cause over-sensitivity for detecting treatment effects in the parametric analyses. Analyses were carried out using the ANOVA directive and APERMTEST procedure of the GenStat 18 statistical package (VSN International 2015).

3.5 Results

3.5.1 Visitor Variables

When the main visitor viewing area window was covered, the proportion of visitors present at this window decreased by about 85% ($F_{1,8} = 117.47$, $p < 0.001$) which was mostly balanced by the increase in the proportion of visitors present at Viewing window 2 ($F_{1,8} = 43.82$, $p < 0.001$; Table 3.3).

Table 3.3. Effects of treatment on ambient noise level and visitor numbers at the penguin enclosure. The means are the mean noise level and number of visitors at the enclosure each day (per six 30 min observation blocks each day). The proportion of visitors at each visitor viewing area window are also shown. Back transformed means are presented in parentheses and any statistical significance ($p < 0.05$) are bolded.

Visitor Variables	Main Window Uncovered	Main Window Covered	s.e.d. ^c	p -value ^a
Ambient noise level (dB)	59	60	0.70	0.38 ^b
Visitors at the enclosure*	15 (228)	13 (181)	1.5	0.28
% Visitors at the main visitor viewing area window**	40 (40)	15 (6.3)	2.3	<0.001
% Visitors at Viewing window 2**	30 (25)	46 (52)	2.5	<0.001
% Visitors at Viewing window 3**	21 (13)	22 (14)	2.8	0.66
% Visitors at Viewing window 4**	27 (21)	31 (27)	2.8	0.23

* Visitors at the enclosure was square root transformed. ** The proportion of visitors at each glass viewing window were angularly transformed ^a p values were calculated using F tests based on one, eight degrees of freedom except for 'Ambient noise level' where the p value was calculated using F tests based on one, seven degrees of freedom (due to 1-day of missing data). ^b p values calculated using permutation test. ^c s.e.d denotes standard error of difference.

As expected, covering the main visitor viewing area window eliminated visitors from interacting with penguins, being on the enclosure ledge and passively standing at this window (Table 3.4). Also, covering the main window decreased the proportion of 60 s sample periods in which visitors made tactile contact with the window, loud vocalisations, and sudden movement at this window ($p < 0.05$; Table 3.4). However, there was no corresponding effect ($p > 0.05$) on ambient noise level in the visitor viewing area, the number of visitors at the enclosure, the proportion of visitors at Viewing window 3 and Viewing window 4 (Table 3.3) or any visitor behaviours at Viewing windows 2, 3 and 4.

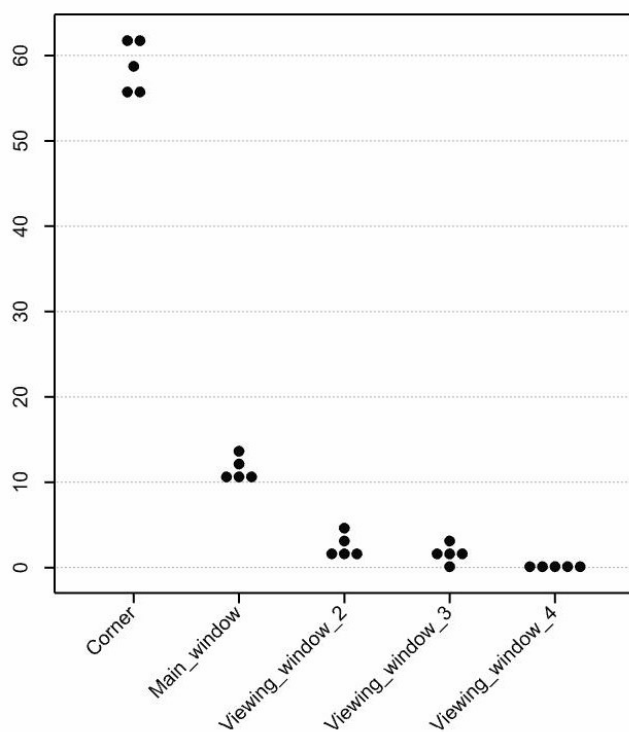
Table 3.4. Effects of treatment on the mean proportion of 60 s sample periods in which visitor behaviours occurred at the main visitor viewing area window (observed in six 30 min observations blocks: total of 180 sample periods each day). Data were angularly transformed. Any statistical significance ($p < 0.05$) are bolded.

Visitor Behaviour	Angularly Transformed			Back Transformed (%)		<i>p</i> -value ^a
	Main Window Uncovered	Main Window Covered	s.e.d ^b	Main Window Uncovered	Main Window Covered	
Tactile contact with glass windows	19	0	2.1	11	0	<0.001
Loud vocalisations	17	8.1	2.0	8.9	2.0	<0.01
Sudden movement	14	5.7	2.6	5.4	0.99	<0.05
Interaction with a penguin(s)	13	0	2.3	4.8	0	<0.001
On enclosure ledge	11	0	3.4	3.6	0	<0.05
Passively observing	7.7	0	2.8	1.8	0	<0.05

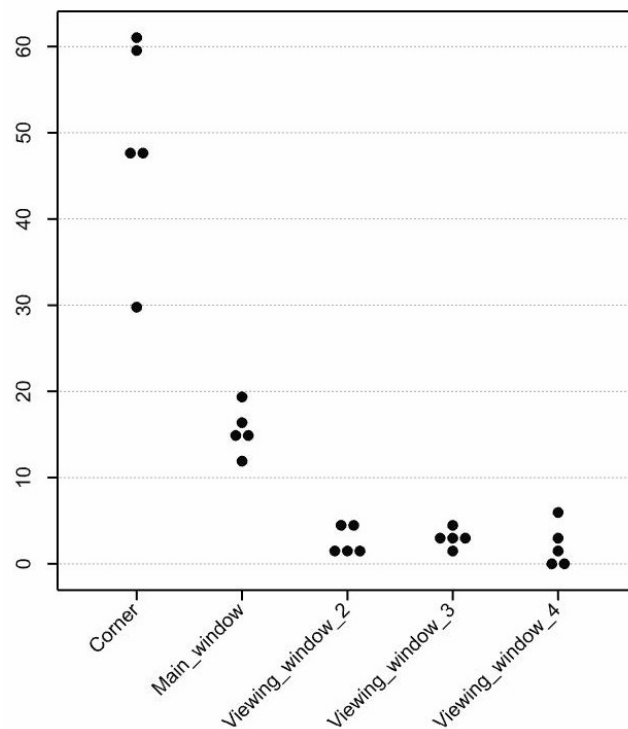
^a *p* values were calculated using F tests based on one, eight degrees of freedom. ^b s.e.d denotes standard error of difference.

3.5.2 Little Penguin Behaviour

The average proportion of penguins visible in the Corner area, depending on the day, varied from 30 to 60% and the proportions of penguins visible in the area near the main window varied from 10 to 20% (Figure 3.6). Also, penguins only spent a small proportion of time in Viewing window areas 2, 3 and 4 (Figure 3.6). Covering the main visitor viewing area window was found to have no effect on the overall proportion of penguins visible except for the proportion of penguins visibly present in the area near the main visitor viewing area window. When the main window was covered, the proportion of penguins present in the area near this main window increased by about 20% ($F_{1,8} = 6.05$, $p < 0.05$; Table 3.5). Furthermore, covering the main window reduced the proportion of visible penguins that were vigilant in the area near this window by about 70% ($F_{1,8} = 6.18$, $p < 0.05$) and increased the proportion of visible penguins preening in the water in the area near this window by about 180% ($F_{1,8} = 5.98$, $p < 0.05$). An approximate 20% reduction in the proportion of visible penguins' surface swimming in the Corner area ($F_{1,8} = 6.21$, $p < 0.05$) was also found when the main visitor viewing area window was covered (Table 3.6). There were no treatment effects ($p > 0.05$) on the other penguin behavioural states or events or in the areas near the other visitor viewing area windows (Table 3.6).



(a)



(b)

Figure 3.6. Dot histograms of the average proportion of penguins visible (%) in each area near the four visitor viewing area windows and the corner with the **(a)** main window uncovered and **(b)** main window covered. Each dot represents observations from a single day.

Table 3.5. The effect of treatment on the proportion of penguins visible (%) overall and the proportion of penguins visible in each area near the four visitor viewing area windows and the ‘Corner’. Data were angularly transformed. Any statistical significance ($p < 0.05$) are bolded.

	Angularly Transformed			Back Transformed (%)		<i>p</i> -Value ^a
	Main Window Uncovered	Main Window Covered	s.e.d ^b	Main Window Uncovered	Main Window Covered	
Penguins visible overall	60	58	2.5	74	72	0.60
Corner	50	45	3.4	59	49	0.14
Main visitor viewing area window	20	23	1.2	12	15	<0.05
Viewing window 2	8.5	9.2	1.4	2.2	2.6	0.60
Viewing window 3	6.7	9.6	1.4	1.4	2.8	0.077
Viewing window 4	2.9	6.5	2.5	0.26	1.3	0.19

^a *p* values were calculated using F tests based on one, eight degrees of freedom. ^b s.e.d denotes standard error of difference.

Table 3.6. The effect of treatment on the proportion of visible penguins in each behaviour (states and events) in the area near the main visitor viewing area window and the 'Corner'. Data were angularly transformed. Any statistical significance ($p < 0.05$) are bolded.

Behaviour	Angularly Transformed			Back Transformed (%)		<i>p</i> -Value ^a
	Main Window Uncovered	Main Window Covered	s.e.d ^c	Main Window Uncovered	Main Window Covered	
Corner (not visible to visitors)						
<i>States</i>						
Surface swimming	59	50	3.9	74	58	<0.05
Diving	10	14	1.8	3.3	6.1	0.068
<i>Events</i>						
Preening (water)	26	25	2.2	19	17	0.66
Allopreen	1.4	1.4	0.37	0.062	0.060	0.98 ^b
Agonistic interactions	3.4	2.9	0.79	0.36	0.25	0.53 ^b
Porpoise	4.1	4.0	0.67	0.51	0.49	0.88 ^b
Fast swimming	7.5	7.2	0.73	1.7	1.6	0.77 ^b
Interaction with glass	0	0	-	0	0	1.0
Manipulate object	0.40	0.95	0.51	0.0049	0.027	0.41 ^b
Bathe	3.1	4.9	2.4	0.29	0.73	0.48
Other	2.4	2.3	0.68	0.18	0.16	0.88 ^b
Main visitor viewing area window						
<i>States</i>						
Huddling	6.0	3.6	2.1	1.1	0.39	0.30
Resting	0	0	-	0	0	1.0
Idle	5.9	5.5	1.5	1.1	0.93	0.81
Locomotion	0.41	0.40	0.57	0.0051	0.0049	1.0 ^b
Vigilant	5.2	3.0	0.88	0.82	0.28	<0.05 ^b
Surface swimming	15	18	2.0	6.7	9.2	0.24
Diving	16	20	2.8	7.9	11	0.29
<i>Events</i>						
Preening (land)	6.6	6.6	1.3	1.3	1.3	0.99
Preening (water)	3.3	5.5	0.90	0.33	0.92	<0.05 ^b
Allopreen	0.63	1.2	0.51	0.012	0.040	0.40 ^b
Agonistic interactions	2.1	2.3	0.59	0.13	0.16	0.75 ^b
Porpoise	3.5	4.3	0.98	0.37	0.56	0.44 ^b
Fast swimming	5.4	6.5	1.1	0.90	1.3	0.33
Interaction with glass	9.1	13	2.2	2.5	5.1	0.12
Manipulate object	6.5	7.3	1.6	1.3	1.6	0.61
Bathe	0.75	1.6	0.61	0.017	0.075	0.24 ^b
Other	0.62	0.27	0.38	0.012	0.0022	0.52 ^b

^a *p* values were calculated using F tests based on one, eight degrees of freedom. ^b *p* values calculated using permutation test. ^c s.e.d. denotes standard error of difference.

3.6 Discussion

Our present experiment aimed to determine the effect of covering the main visitor viewing area window on little penguin behaviours indicative of fear, such as huddling, avoidance and vigilance. Covering the main visitor viewing area window increased the proportion of penguins present and the visible penguins preening in the water and decreased the proportion of visible penguins vigilant in the area near the main window. This provides some evidence that the little penguins in this exhibit showed an aversion to the area near the main window when it was uncovered, with the reduced presence of the penguins and increased vigilance reflecting increased avoidance of and alertness towards visitors respectively. This suggests unobstructed visual contact with visitors may be fear-provoking for these little penguins. The reduced preening in the water also suggests that contact with visitors may be threatening for little penguins since preening behaviour is a comfort behaviour that is more likely to occur when animals are not threatened (Ainley 1974; Delius 1988; Boissy *et al.* 2007; Zimmerman *et al.* 2011). The results in the present study are supported by two experiments on zoo-housed little penguins where the presence and close viewing proximity of visitors increased vigilance and avoidance behaviours and reduced preening in the water in little penguins at Melbourne Zoo (Sherwen *et al.* 2015b; Chiew *et al.* 2019a). Also, this is consistent with Klomp *et al.* (1991) and Weerheim *et al.* (2003) who found wild little penguins increased their avoidance of areas with high human traffic and footpaths when nesting. Although the effects of visual contact were not specifically examined in these studies, it can be surmised that visual contact may be a key component to little penguin fear of visitors. However, it is important to note that vigilance is not always an indicator of fear and may indicate curiosity and since the main window was randomly covered for five 1-day periods over 2 weeks, the novelty of covering the window and the associated changes such as illumination in the area, may have stimulated inspection (Beauchamp 2017; Sherwen and Hemsworth 2019). Consequently, this may explain the increased presence of penguins in the area near the main window during this treatment imposition. Zoo-housed little penguins have been found to show curiosity to novelty, particularly to mirrors likely due to the reflective properties appealing to them (Hall *et al.* 2018). This may be true in the present experiment where covering the main visitor viewing area window using the barrier may have increased the reflective properties of this window. However, this requires further research to tease out the effects of novelty of an exhibit manipulation and its potential effects on penguin responses to visitors.

Covering the main visitor viewing area window decreased all visitor behaviours at this window that may be fear-provoking for penguins such as tactile contact with the glass viewing window, loud vocalisations, and sudden movement. This is to some extent supported by previous studies that, while not measuring visitor behaviour specifically, found camouflage netting and one-way vision screens improved gorilla and black-capped capuchin welfare through the reduction of visual contact with visitors but also likely by reducing potentially threatening visitor behaviours as a result of the visual barriers being in place (Blaney and Wells 2004; Clark *et al.* 2012; Sherwen *et al.* 2015a). Our present experiment also found that when the main window was covered, the overall number of visitors at the enclosure did not change but did reduce the proportion of visitors present at the main window. The number of visitors at the main window was balanced by the increase in the number of visitors present at the adjacent viewing window, Viewing window 2. A possible explanation may be that visitor dwell time and visitor viewing experience were not adversely affected by the visual barrier, but this requires further investigation. This contrasts with previous studies on little penguins that had reductions in visitor numbers when barriers were used to regulate visitor-animal interactions (Sherwen *et al.* 2015a; Chiew *et al.* 2019a).

Little penguins, like all penguin species, have very good vision as they are visual predators that rely on their vision to find and catch prey underwater (Stahel and Gales 1987; Preston 2008). Also, being the smallest and only penguin species whose activity on land is strictly nocturnal, having good vision is important for this species (Stahel and Gales 1987; Rodriguez *et al.* 2016). Good vision aids in the avoidance of predators especially for little penguins who have terrestrial, aerial and aquatic predators (Stahel and Gales 1987; Dann 1992; Bool *et al.* 2007; Wiebkin 2011). Consequently, it would not be surprising that visual contact with visitors affected avoidance, vigilance, and preening behaviour in little penguins in our present experiment. However, it is unclear in the present experiment whether these behavioural changes in penguins when the main window was covered were due to simply eliminating visual contact with visitors at this window *or* reducing other aspects of visitor contact such as potentially fear-provoking visitor behaviours. In the present experiment, the visual barrier placed on the main visitor viewing area window reduced all potentially fear-provoking visitor behaviours such as tactile contact with the glass window, ground vibrations created by visitors from sudden movement and loud vocalisations. These visitor-induced sounds and vibrations in the water may be fear-provoking for little penguins. Research has found both substrate-borne vibrations and water-borne sounds can affect the behavioural responses of many marine species, particularly fish, and can be an important source of information for predator

avoidance or prey detection (Sand and Karlsen 1986; Hill 2009; Roberts 2015; Roberts and Laidre 2019). Water is also an effective medium for sound propagation as a result of its low absorption rates and low attenuation which allows sound to travel five times faster in water compared to air (Roberts 2015). Thus, in addition to visual contact with visitors, visitor-induced sounds and vibrations may have been fear-provoking behaviours for the study penguins resulting in both increased avoidance and vigilance and reduced preening in the water in the area near the main window when the visual barrier was not in place. Interestingly, Higham and Shelton (2011) found wild little penguins have an intrinsic tolerance to boat engine vibration and noise where the authors suggested that this shows little penguins can habituate to human presence. However, vibrations and noise cause by mechanical equipment may be perceived differently by little penguins compared to vibrations and noise caused by humans directly. Further research is required to understand the effects of visitor-induced sounds and vibrations on little penguin fear responses as studies have shown that regulating close visitor contact and potentially fear-provoking visitor behaviours using management strategies, such as effective signage or barriers, can reduce the adverse effects of visitors on animals (Kratochvil and Schwammer 1997; Blaney and Wells 2004; Seddon and Ellenberg 2008; Chiew *et al.* 2019a).

The high proportion of visible penguins in the Corner area whether the main visitor viewing area window was covered or uncovered indicates that the penguins had a preference for the Corner area in comparison to other areas of the exhibit. The Corner area allowed the penguins to be visually hidden from visitors by the solid wall of the pool and therefore this area may have provided the penguins with an opportunity to avoid visitors and reduce the perceived close proximity of visitors which may be something zoos should consider for their animals. This further supports our interpretation that visitors may be fear-provoking for little penguins in this exhibit. Research has shown that an area in which to retreat may minimise visitor-induced stress on zoo animals by providing a level of choice and control over their interactions with visitors (Morgan and Tromborg 2007; Mason 2010; Mun *et al.* 2013; Collins *et al.* 2017). Similarly, increased separation between visitors and penguins has shown to minimise the effects of visitors on little penguin fear responses (Chiew *et al.* 2019a). Consequently, penguins in zoos may benefit from ameliorations such as one-way viewing glass, barriers to close visitor contact and areas for penguins to retreat. However, this Corner area may have been also attractive to the penguins because it was the deepest part of the pool and was located next to the breeding group of adult penguins, where the two groups had visual contact with each other. Little penguins are a highly social species and in the wild live in colonies

like all penguin species and thus, it is not surprising that social contact with the adult penguins may have attracted the penguins to the Corner area (Reilly and Cullen 1982).

The apparent fewer visible penguins surface swimming in the Corner area is anomalous because it contradicts previous findings that close contact with visitors reduces surface swimming. Sherwen *et al.* (2015b) found that closing the exhibit to visitors increased surface swimming and Chiew *et al.* (2019a) found that increased separation between visitors and penguins increased surface swimming in little penguins. In the present experiment when penguins were in the Corner area, they could not see visitors at the main visitor viewing area window so this would have expected to result in an increase in surface swimming from the lack of visual contact with visitors. However, it is not clear why surface swimming was affected by treatment in the Corner area in the opposite direction to what has been previously found and since it was unaffected in the area near the main window.

The findings from the present experiment at Taronga Zoo support those from the two previous experiments at Melbourne Zoo by the authors that some types of visitor contact may be fear-provoking (Sherwen *et al.* 2015b; Chiew *et al.* 2019a). While the present experiment found some relatively moderate effects of reduced visitor contact on avoidance and vigilance behaviour, the two experiments at Melbourne Zoo found strong effects of reduced visitor contact on avoidance, huddling and vigilance behaviour, as well as surface swimming. It is not surprising that there are some differences in the magnitude of the treatment effects between these experiments since the treatments differed substantially. In particular, the experiments at Melbourne zoo examined the effects of closing the enclosure to visitors and regulating visitor viewing proximity on the penguins, while the present experiment examined the effect of covering the main visitor viewing area window, but not the other three visitor viewing area windows. Furthermore, there were differences between experiments in keeper management practices, enclosure design and thus the type of possible visitor interactions such as close contact and visitor encounters, as well as individual animal characteristics such as past experiences and coping style. For example, at Melbourne Zoo, visitors were able to view the penguins from most of the perimeter of the enclosure and along the main length of the pool where there were opportunities, if visitors chose, to make tactile contact with the penguin pool or the penguins themselves by looming over the pool edge. In the present experiment, the enclosure is long and thin with a long water course and elongated stretch of land and the visitor viewing area was limited to one side of the enclosure where visitors were primarily positioned below the penguins, viewing the penguins mostly under water through the glass windows. This enclosure design may have helped

ameliorate any fear-provoking aspects of visitors. The little penguins in the present study also may have had more opportunity to habituate to visitors because unlike the penguins at Melbourne Zoo, these penguins had daily visitor encounters (Fowler 1999; Ratz and Thompson 1999; Ellenberg *et al.* 2009; Villanueva *et al.* 2012). However, considering the behavioural changes in the present study, it is possible that the behavioural response towards visitors by penguins during a close-up encounter, involving controlled visitor-penguin interactions, may differ from their responses to visitors normally viewing them on exhibit from the visitor viewing area where visitors can be unpredictable and intense and thus, are uncontrolled visitor-penguin interactions.

An obvious question arising from these three experiments is the implications of the customary visitor contact on the welfare of penguins at these two enclosures. Chiew *et al.* (2019a) found that either the installation of a physical barrier or by closing the exhibit to visitors strongly reduced little penguin behaviours indicative of fear, but did not affect faecal glucocorticoid metabolites. The authors suggested that although fear responses to visitors were observed when visitor viewing proximity and behaviour were uncontrolled which is a welfare concern, these fear responses such as avoidance may have been an effective adaptive response in ameliorating the activation of the hypothalamo–pituitary–adrenal (HPA) axis. The authors also suggested that the treatment period may have been insufficient to elicit a measurable change in faecal glucocorticoid metabolites concentrations (i.e., sustained activation of the HPA axis). Therefore, avoidance of the area near the main window by the penguins in the present study, as well as preference for the Corner area of the pool, which was hidden from visitors, may have been successful in reducing the penguins' welfare risks from visitor contact at the main window. Clearly, further research on the effects of the nature and intensity of visitor contact on both the behaviour and stress physiology of little penguins would be prudent. For example, this could entail systematically varying enclosure design or imposing treatments for more than one or two-day periods and measuring the effects on animal behaviour and other physiological measures such as faecal glucocorticoid metabolites and heart rate.

3.7 Conclusions

This experiment provides limited evidence that little penguins in this exhibit showed an aversion of the area near the main visitor viewing area window when it was uncovered, suggesting that visitors may be fear-provoking for these little penguins. However, it is unclear whether the apparent aversion of this window when uncovered was due to simply having visual contact with visitors and/or other aspects of visitor contact occurring at the window such as potentially fear-provoking visitor behaviours. This interpretation is supported by the observation that the penguins spent most of their time in the Corner area where visitors were not visible to the penguins. Therefore, the welfare implications of leaving the main window uncovered on these little penguins may have been minimal but it does suggest that penguins in zoos may benefit from modifications to the enclosure that may ameliorate penguin fear responses to visitors such as one-way viewing glass, barriers to close visitor contact and areas for penguins to retreat.

Author Contributions: S.J.C., P.H.H., S.L.S., G.J.C., V.M. and A.B. designed the experiment. P.H.H., S.L.S., G.J.C., and V.M. supervised S.J.C. S.J.C., with assistance from V.M. and A.B., liaised with the Great Southern Oceans keeping team at Taronga Zoo (Taronga Conservation Society Australia). S.J.C. was responsible for communicating with all other staff, interns, and students from the Animal Welfare Science Centre (University of Melbourne) and organising and carrying out the data collection. K.L.B. aided S.J.C. with the statistical analysis of the data. S.J.C. wrote the original draft paper. P.H.H., S.L.S., G.J.C., V.M., A.B. and K.L.B. contributed feedback and additions to the paper. All authors have read and agreed to the published version of the manuscript.

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Chapter 4

Effects of the Presence of Zoo Visitors on zoo-housed Little Penguins (*Eudyptula minor*)

This chapter presents result on the effects of zoo visitor presence on little penguins housed at Wellington Zoo (Wellington, New Zealand).



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4.1 Abstract

Little penguins (*Eudyptula minor*), or Kororā in Māori, show variation in their behavioural responses towards zoo visitors in Australian zoos. We experimentally examined the effects of visitor presence on the behaviour and stress physiology of little penguins at Wellington Zoo, New Zealand. The two treatments were: 1. Visitor presence - the exhibit was open to visitors; and 2. Visitor absence - the exhibit was closed to visitors. We found that when the exhibit was closed to visitors, the percentage of penguins observed close to the visitor viewing pier increased from about 1% to 9%, but there was little effect on other behaviours and faecal glucocorticoid metabolite concentrations. This result of increased avoidance of the visitor viewing pier when the exhibit was open to visitors suggests close visitor contact, particularly from above, may be fear-provoking for these penguins. We conclude that designing enclosures to allow close viewing proximity of visitors, such as visitors looming over the pool, may be futile in improving visitor experience, since this species of penguins is likely to avoid these types of viewing areas when visitors are present. Visitors positioned close to and above penguins may be particularly problematic since visitors in this position may be perceived as threatening.

Keywords: little penguins; Kororā; zoos; visitor presence; visitor-animal interactions; visitor effect; New Zealand

4.2 Introduction

Little penguins (*Eudyptula minor*), also known as blue, little blues, or Kororā in Māori, are the smallest species of penguins and endemic to the southern parts of Australia and New Zealand (Stahel and Gales 1987; BirdLife International 2020). Globally, the conservation status of little penguins is 'Least Concern' but, there is evidence of declining wild population numbers (Williams *et al.* 2009; Smith 2013; Robertson *et al.* 2017; BirdLife International 2020). In Australia, numerous little penguin colonies have shown substantial decline over the past several decades (Dann 1992; Stevenson and Woehler 2007; Colombelli-Négrel 2015; BirdLife International 2020). In New Zealand, populations are also showing signs of decline and so, are considered 'at risk' (Heber *et al.* 2008; Robertson *et al.* 2017; BirdLife International 2020). This general decline in wild little penguin populations across Australia and New Zealand is driven by various factors such as predation by introduced species (e.g., foxes (*Vulpes vulpes*), domesticated dogs (*Canis*

lupus familiaris), feral cats (*Felis catus*), climate variability, habitat loss and human disturbance (Dann and Norman 2006; Agnew *et al.* 2013; BirdLife International 2020). In particular, there is growing concern of the negative effects associated with increased human presence from wildlife tourism and other human disturbances on little penguin behaviour, reproductive success, and population size (Carney and Sydeman 1999; Shaughnessy and Briggs 2009; Higham and Shelton 2011; Tisdell and Wilson 2012; Colombelli-Négrel 2015; Rodríguez *et al.* 2018). For example, weekly nest box inspections by researchers and the close proximity of visitors were found to reduce burrow occupancy and hatching success in little penguin colonies on Penguin Island, Western Australia (Klomp *et al.* 1991; Wienecke *et al.* 1995). Similarly, areas of high human traffic and visitor paths, particularly those also utilised by arriving penguins, were found to increase nest displacement and reduce the number of little penguins landing in those areas of the beach (Weerheim *et al.* 2003; Giling *et al.* 2008; Shaughnessy and Briggs 2009). In contrast, some studies have suggested minimal effect of human disturbances on the breeding success and survival rates of little penguins when disturbances are relatively low or well-regulated (Dann 1992; Dann 1994; Rogers *et al.* 1995; Perriman and Steen 2000; Shaughnessy and Briggs 2009; Wiebkin 2011; Agnew and Houston 2020). This variation in the reported literature on the effects of human disturbances on little penguins shows the need for further research to understand how penguins perceive human presence. By understanding this relationship between humans and penguins, it will aid the development of appropriate strategies to manage human-penguin interactions and safeguard the welfare of penguins.

Most research to date on the effects of human disturbances on wild little penguins has been on colonies in Australia, despite little penguins also being a highly valued and a protected native species in New Zealand. Only one study, to our knowledge, has been conducted on wild little penguins in New Zealand. No detrimental effect of human disturbances was found on the reproductive success of the Oamaru Blue Penguin Colony which was exposed to tourists compared to the Oamaru Creek Penguin Refuge that had no public access (Agnew and Houston 2020). This was likely the result of the tourism operation at the Oamaru Blue Penguin Colony implementing strategies to regulate human disturbances such as reduced noise, light and movement from visitors and restricted visitor viewing areas; effects that are consistent with past research (Dann 1992; Rogers *et al.* 1995; Shaughnessy and Briggs 2009; Wiebkin 2011; Agnew and Houston 2020). Also, this research adds to the growing evidence that little penguins, found at different locations, may respond to visitors in a similar manner if the nature of visitor contact is the same (Klomp *et al.* 1991; Weerheim *et al.* 2003; Giling *et al.* 2008; Carroll *et*

al. 2016). However, penguin responses may vary as a result of characteristics of the environment differing at each location which may influence the nature of visitor contact. This is beginning to be observed in research on the effect of visitors on zoo-housed little penguins which has also focused, thus far, only on Australian zoo-housed little penguins (Sherwen *et al.* 2015; Chiew *et al.* 2019a; Chiew *et al.* 2020).

Behaviours such as huddling, vigilance and in particular avoidance, have been widely documented as indicators of fear of humans in animals and linked with physiological correlates of fear such as increased blood glucocorticoid and glucocorticoid metabolite (GM) concentrations (Gray 1987; Hemsworth and Coleman 2011; Hemsworth *et al.* 2018; Sherwen and Hemsworth 2019). The physiological stress response to challenges nearly always includes activation of the sympatho-adrenal medullary system and the hypothalamo–pituitary–adrenal axis, with the consequent increase in synthesis of catecholamines and glucocorticoids, respectively (Sapolsky 2002; Tilbrook and Ralph 2018). Any free (unbound) glucocorticoids are excreted through the urine or faeces which can then be sampled to measure GM concentrations (Möstl and Palme 2002; Palme *et al.* 2005; Sheriff *et al.* 2010). Faecal glucocorticoid metabolite (FGM) concentrations are a commonly used measure of physiological stress in zoo animals, including zoo-housed penguins, because of its non-invasive sampling technique and ability to reliably reflect plasma glucocorticoid concentrations (Shepherdson *et al.* 2004; Sheriff *et al.* 2010; Sheriff *et al.* 2011; Ozella *et al.* 2015; Chiew *et al.* 2019a; Palme 2019; Scheun *et al.* 2020). Consequently, using both behavioural and physiological measures of fear of humans in animals allows for a more robust assessment of the effect humans on zoo-housed penguin welfare.

While still limited, there is evidence from studies in Australian zoos that close visitor contact may be fear-provoking for zoo-housed little penguins. Sherwen *et al.* (2015) found increases in huddling, vigilance, aggression and avoidance and reductions in swimming by little penguins when visitors were present at Melbourne Zoo (Victoria, Australia). Similarly, at the same zoo, Chiew *et al.* (2019a) found that close visitor viewing proximity primarily influenced little penguin fear responses. However, increased separation between visitors and the penguins using a physical barrier reduced these fear responses (Chiew *et al.* 2019a). Also, little penguins at Taronga Zoo (New South Wales, Australia) showed some avoidance of visitors, indicated by the aversion of the area near the main visitor viewing window when visual contact with visitors was not obstructed, and the preference for an area not visible to visitors (Chiew *et al.* 2020). The response by the little penguins at Taronga Zoo was suggested to be less pronounced than that at Melbourne Zoo because of the different enclosure designs that altered the nature of visitor contact,

particularly in regard to the intensity of visitors (Chiew *et al.* 2020). These three studies on the effects of visitors on zoo-housed little penguins at two Australian zoos demonstrate the possible risk factors such as environment characteristics (e.g., enclosure design and management) that influence visitor-penguin interactions. However, further research is still required to fully comprehend the similarities or variation in little penguin fear responses towards visitors and the factors that influence the interactions between visitors and penguins across zoos.

Research has suggested that there are two congeneric taxa of little penguins; *Eudyptula novaehollandiae* being little penguins occurring in Australia and south east New Zealand (Otago) and *Eudyptula minor* being little penguins occurring in all other parts of New Zealand (Peucker *et al.* 2009; Grosser *et al.* 2015; Grosser *et al.* 2016; Grosser *et al.* 2017). This genetic difference has been suggested to be linked to some morphological and behavioural differences between these two distributions of little penguins (Grosser *et al.* 2015; Grosser *et al.* 2017). For example, it has been reported that Australian little penguins commonly come ashore after dusk in 'rafts' where they swim ashore in groups, walk together to their nest areas and are capable of double brooding (Grosser *et al.* 2015). These behaviours have not been as frequently observed in the New Zealand lineage of little penguins potentially because of genetic differences. However, these behavioural differences could also be due to lower population numbers of New Zealand lineage colonies in comparison to the Australian colonies, or due to the generally limited monitoring efforts over large parts of New Zealand (Dann 1994; BirdLife International 2020; Cargill *et al.* 2020). In Wellington (New Zealand), little penguins have been identified to be genetically different from Australian little penguins (i.e., *Eudyptula minor* lineage), with some degree of hybrid ancestry in this population (Grosser *et al.* 2015). Therefore, the little penguins in the present experiment may have differed genetically from the little penguins studied in Australian zoos. Anecdotally, zoo staff at Wellington Zoo also suggested that the little penguins in their zoo were more pair driven, less colony driven and shyer than Australian little penguins (M. Forbes and S. Eyre, pers. comm., 2018). Hence, further examination to determine the extent in which the effects of visitors on *Eudyptula novaehollandiae* are reflected in *Eudyptula minor*, both in the wild and in captive settings like zoos is needed.

The present experiment investigated the effects of visitor presence at the little penguin exhibit at Wellington Zoo (Wellington, New Zealand) on penguin behaviours indicative of fear such as avoidance, huddling and vigilance, and on the stress physiology of the penguins. This research will help improve the management of visitor-penguin interactions both in zoos and in the wild.

4.3 Methodology

4.3.1 Study species, Housing and Husbandry

This research was approved by the Victoria University of Wellington Animal Ethics Committee (approval number 25504) and was conducted at Wellington Zoo's Meet the Locals – He Tuku Aroha little penguin enclosure (Wellington, New Zealand). This 225 m² enclosure consists of a large pool that is surrounded by a pebble shoreline, trees, rocks, and shrubs as well as a partially upturned boat for shelter and five nest boxes (Figure 4.1-4.3). The visitor viewing area consists of a viewing pier that extends 2 m out over a proportion of the pool and an area along one side of the exhibit which is surrounded by a 1 m tall wooden fence and a visitor pathway approximately 4.2 m wide (Figure 4.1-4.3). Visitors also have opportunities to view the penguins from a visitor viewing hide at the back of the enclosure where the penguins' view of visitors is obstructed (Figure 4.1-4.3). However, preliminary observations found that this hide was rarely used by visitors. During the study, the enclosure housed six wild-born little penguins (three males and three females) rescued from the wild in New Zealand due to sustained injuries (e.g., blind in one eye, loss of one wing or eye). Four of the birds came from the Wellington coast, one from Nelson and one from Whanganui. They were fed at 9:00 h and 15:00 h each day. The afternoon feeding was accompanied by a keeper presentation where visitors watched from outside the enclosure, primarily from the visitor viewing pier and Path 1 (Figure 4.1). Husbandry followed normal routines and remained consistent throughout the course of the study.

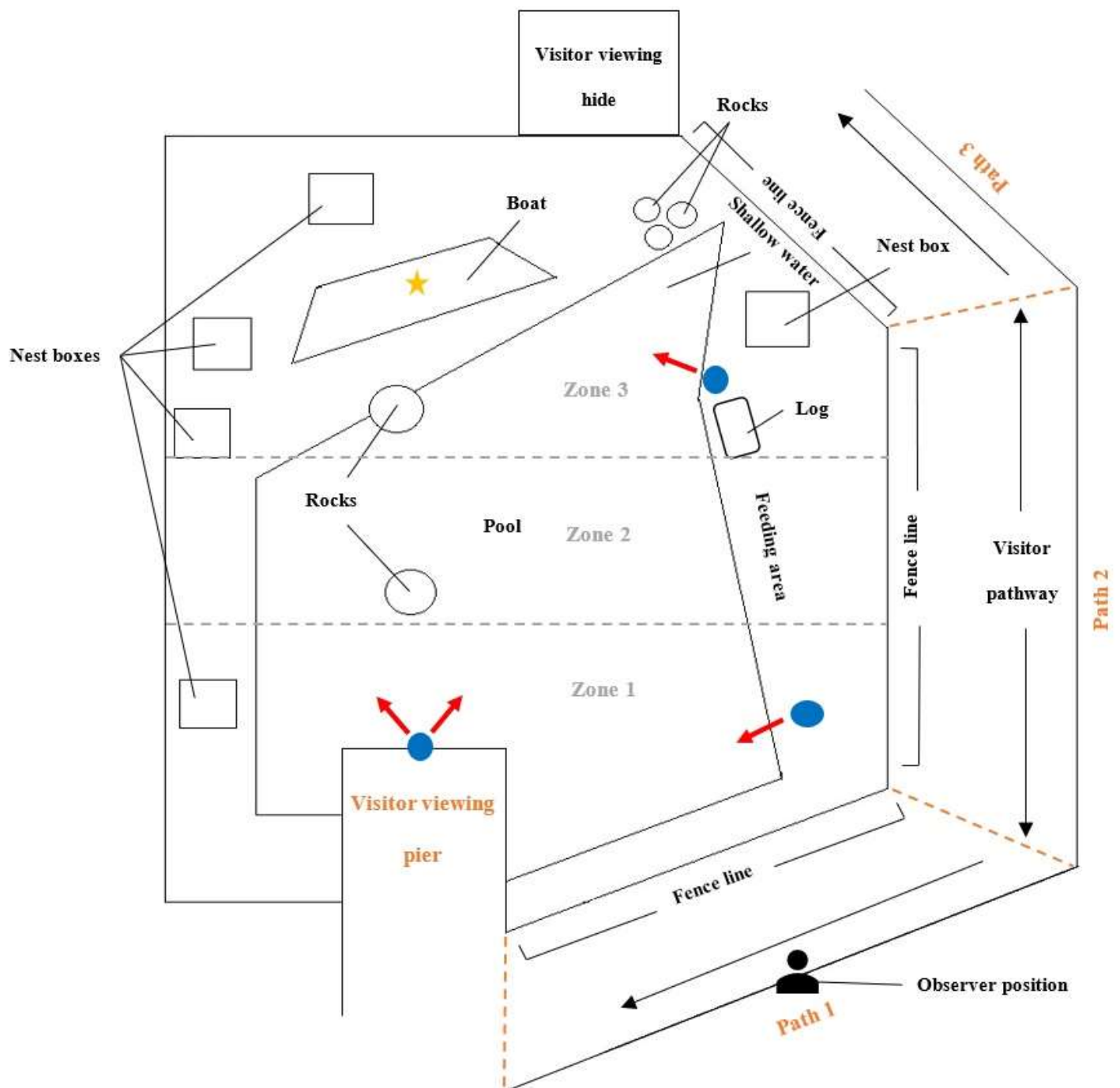


Figure 4.1. Schematic of the little penguin exhibit at Wellington Zoo. The blue circles represent the position of the cameras, the red arrows indicate the direction of the cameras and the star represents the position where an extra camera was placed. The orange dotted lines show the division of the visitor viewing area into four sections in the exhibit: The Visitor viewing pier and Paths 1, 2 and 3 (in orange). The grey dotted lines delineate the Zones 1, 2 and 3 in the enclosure in which the position of the penguins was observed relative to the visitor viewing pier.



Figure 4.2. Meet the Locals - He Tuku Aroha, little penguin exhibit at Wellington Zoo.

4.3.2 Study design

A two treatment fully randomised design was used to examine the effects of visitor presence on little penguins. The two treatments were:

1. **Visitor presence (Control)** - the exhibit was open to visitors as usual (standard zoo conditions).
2. **Visitor absence (Treatment)** - the penguin exhibit was closed to the public. Visitors were prevented from accessing the exhibit by closing two visitor access points. However, penguins could still hear but not see visitors at nearby exhibits of other animal species.

Each treatment was randomly imposed for 2-day periods, two imposition periods per week (Monday and Tuesday; Thursday and Friday), with five replicates of each treatment (total of 20 study days). The study was conducted over five weeks during May and June 2018 (Autumn-Winter). Weekends, public holidays, and school holidays were avoided to circumvent the normal variation in visitor numbers that occurs on weekends and school/public holiday periods. One week out of the five weeks had treatments with no day separation between the two imposition periods because a public holiday occurred on the Monday.



Figure 4.3. (a). The fence line and vegetation in Path 2 of the visitor viewing area and (b). The fence line in Path 3 of the visitor viewing area and the visitor viewing hide.

4.3.3 Animal behavioural observations

Four HERO 5 GoPro cameras were placed around the enclosure, covering the main areas utilised by the penguins to record penguin numbers and behaviours indicative of fear between 08:45-16:00 h (Table 4.1). Only three of the four cameras were used for behavioural observations and analysis as the fourth camera was only used if the observer could not see penguins under the boat clearly from the other cameras or had doubt in the behaviour(s) displayed under the boat. Despite the penguins being distinguishable by their physical features, observation of the camera footage was not able to clearly discern these physical differences and so, penguin behaviour was recorded at the group level.

Penguin behavioural data were transcribed during the playback of video footage on all study days in 3 x 1 h observation blocks (10:30-11:30 h, 12:00-13:00 h, 13:30-14:30 h). Instantaneous point sampling and one-zero sampling were used for behavioural patterns that were considered states (i.e., of an appreciable duration) and events (i.e., relative short durations), respectively (Table 4.1). Instantaneous point sampling at 3 min intervals recorded the number of visible penguins in each behavioural state and one-zero sampling in 30 s periods, within each 3 min interval, was used to record the number of visible penguins displaying each behavioural event. The visitor viewing pier was identified during preliminary observations to be the main viewing area for visitors, based on visitor numbers. Paths 1, 2 and 3 were generally where visitors walked and the penguins' view of visitors in these sections were markedly obstructed by the vegetation between the pathway and penguins in the exhibit, especially in Paths 2 and 3 (Figure 4.1-4.3). Therefore, the enclosure was divided into three zones based on the distance from the visitor viewing pier: Zone 1 was 0 - 4 m, Zone 2 was 4 – 7 m and Zone 3 was greater than 7 m from the visitor viewing pier (Figure 4.1). The number of penguins visible in each zone was also recorded. All behaviours were mutually exclusive except for 'location in enclosure' and 'huddling'.

Table 4.1. Ethogram of penguin behaviour. Adapted from Chiew *et al.* (2019a) and Chiew *et al.* (2020).

Behaviour	Description
States	
Location in enclosure	Zone 1: 0-4 m from visitor viewing pier.
	Zone 2: 4-7 m from visitor viewing pier.
	Zone 3: greater than 7 m from visitor viewing pier.
Huddling (land)	Stationary, positioned within one wing distance of at least one other penguin.
Surface swimming	Moving or floating on the surface of the water, with head erect or in the water.
Diving	Moving under water surface.
Resting (land)	Belly on the ground, in a prone position, with eyes open or closed.
Idle (land)	Standing on two feet with a relaxed posture, eyes open or closed; not visually scanning environment.
Locomotion (land)	Upright position, moving from one location to another either by walking or running.
Vigilance (land)	Standing on two feet, visually scanning the environment with head movements from left to right or vice versa.
Events	
Preening (on land)	Running bill through plumage on land.
Preening (in water)	On the surface of the water and running bill through plumage.
Allopreening	Running bill through the plumage of another bird(s).
Agonistic interactions (maybe a combination of these behaviours)	Peck: Directed at another individual in which an individual directly hits or strikes at another bird with its bill.
	Lunge: sudden forward thrust of the body towards another individual.
	Chase: an individual runs after another individual.
	Threat: standing erect, approaching another individual, with

	wings spread back and head in a bowed/bent downward position (with or without vocalisations).
Bathing	In the water, twisting body from side to side in a shaking, rotary motion.
Body shake (land)	Standing on two feet, the body moves with a vigorous twisting motion causing the body to stretch up, the wings to move back and forth and the head to twist in a rotary movement with the body.
Head shake/flick (land)	Quick head movements from side-to-side on land.
Beak movement display (land)	Standing on two feet, with beak pointed directly upwards, opening, and closing mouth.
Social interaction	Nibbling another individual's beak and/or slow touch of beaks.
Scratching (land/water)	Running foot through feathers, primarily head and neck area, in a quick up and down motion.
Other	Any other behaviour not described e.g., stretch, manipulate object

4.3.4 Penguin faecal sampling and analysis: Faecal Glucocorticoid Metabolites (FGM)

Faecal samples were collected by the principal investigator (SJC), adopting the methodology applied in Chiew *et al.* (2019a). Samples were collected at the end of each treatment day between 15:30 and 16:00 h and were immediately stored in a freezer at -20°C. Most samples were collected from the penguins' nest boxes which were known by keepers to be used by the same individual or pair of individuals each day. Therefore, samples collected from nest boxes were able to be identified to specific individuals or pairs. This ensured that samples were not biased by particular individuals or pairs. An average of 11 samples (range 3-18) were collected per day for the group of six penguins, for a total of 219 samples. Two samples were excluded due to being exceedingly small (i.e., weighing less than 0.005 g). Approximately 84% of the samples were collected from known individuals or nest boxes, allowing us to ensure good sampling across the population.

Steroid extraction and assay procedures followed those previously described (Sherwen and Fanson 2015; Chiew *et al.* 2019a). FGM concentrations were measured and analysed

using a double-antibody cortisone enzyme-immunoassay that has been biologically validated for little penguins (provided by R. Palme, University of Veterinary Medicine, Vienna, Australia) (Sherwen and Fanson 2015). Samples were assayed in duplicates and data are expressed as ng/g dried faeces for final concentrations. The intra-assay CV was less than 15% and inter-assay CV's were 5.62% and 10.04% for low and high controls, respectively.

4.3.5 Visitor behavioural observations

Visitor observations were conducted directly by the principal investigator (SJC) in seven 30 min observation blocks between 09:30 and 15:00 h. Instantaneous point sampling at 3 min intervals was used to record visitor number (number of adults and children within 1m of enclosure) in each of the four sections of the visitor viewing area i.e., the Visitor viewing pier, Paths 1, 2 and 3 (Figure 4.1). Within each 3 min interval, visitor behavioural events were recorded continuously to record the total frequency of bouts of these behaviours (occurrences per observation block per day), irrespective of how many people were displaying the behaviours (Table 4.2). The visitor behavioural events were recorded to capture the types of behaviours visitors displayed while at the little penguin exhibit (Table 4.2). These observations were made from Path 1 of the visitor viewing area in a position that allowed full view of the visitor viewing area to record visitors in a manner that reduced the effect of the researcher's presence on the penguins (i.e., stationary, or slow movement positioned 4.5 m from the enclosure; Figure 4.1). It should be noted that Paths 1, 2 and 3 had concrete edging and/or vegetation that restricted visitors from directly standing up against the fence lines (Figure 4.2 and 4.3). Ambient noise level was recorded continuously using a sound level data logger (Standard ST-173) which was placed inside the penguin enclosure on top of the boat shelter.

Table 4.2 Ethogram of visitor behaviours. Adapted from Chiew *et al.* (2019a) and Chiew *et al.* (2020).

Behaviour	Description
Loud vocalisations	Shouts, screams, squeal, cry, or loud whistles.
Looming	Leaning on or over the enclosure barriers to view animals in the water or on land.
Sudden movement	Running, waving, or jumping towards or at the penguin(s) and/or enclosure.
Throwing objects	Tossing any food, maps, sticks or other inanimate objects at penguin(s) or into the enclosure.
Standing on ledge	Upright position, stationary, and on a ledge or enclosure structure (i.e., sign/concrete ledge) to view penguins
Passively observing	Upright position, stationary, and viewing penguins and/or their enclosure. Not talking.
Walking	Moving at a regular pace by lifting and setting down each foot in turn, never having both feet off the ground at once.
Walking on ledge or signage	Moving at a regular pace by lifting and setting down each foot in turn while on the concrete ledge or signage of the enclosure.
Taking a picture	Using a phone or other camera device to photograph the penguins.
Crouch	Positioned lowered to the ground where the knees are bent, and the upper body is brought forward and down.
Entered visitor viewing hide	Visitor(s) went into the provided visitor viewing hide at the top of the enclosure to view penguins.
Other	Any other behaviour not described e.g., copying penguin vocalisations, sitting on enclosure signage or bench, hit enclosure signage, touching pool water, climbing enclosure structures.

4.3.6 Statistical analysis

Visitor variables were only recorded on days the exhibit was open. The sum of adults and children were used to calculate visitor number totals. The sum of visitor behaviours displayed was used to calculate visitor behaviour frequencies for each day. Both visitor numbers and visitor behaviour frequencies were then averaged for each day and hour (per day), respectively, with between day standard deviation or dot histogram of daily values as a measure of variance. Ambient noise level was continuously recorded on all study days and so, was averaged over the 2-day treatment imposition periods to obtain a single summary value.

Each penguin behaviour measurement was averaged over the two days of each treatment imposition period, to obtain a single summary value for each 2-day imposition period. The percentage of penguins visible was calculated by totalling the number of penguins recorded visible each day divided by the total number of counts of penguins present each day (i.e., six x number of samples taken on the day), then multiplying by 100, and finally averaging over the two days of each treatment imposition period. The percentage of penguins observed in each 'Zone' was handled in a similar manner whereby the total number of penguins recorded visible in each zone each day was divided by the total number of counts of penguins present each day, before being multiplied by 100. For animal behavioural states, the percentage of visible penguins observed displaying each behavioural state was calculated by totalling the number of penguins recorded in each behavioural state each day divided by the total number of penguins recorded visible each day, and then multiplying by 100. Animal behavioural events were handled in a similar manner whereby the total number of penguins displaying each behavioural event each day was divided by the total number of penguins visible within each 30 s period per day. These animal behaviour measures were subsequently averaged over the 2-day imposition periods of each treatment to obtain a single summary value. For FGM, the daily average for each known individual or pairs was calculated, and then all samples were averaged over the two days for each treatment imposition period to obtain a single summary value for the entire population.

Prior to statistical analysis, the summary values for animal behaviour (state and events), were angularly transformed. This ensured that the residual variation was similar in all treatments, and the distribution of residuals had minimal skewness. No transformation was required for ambient noise level. Furthermore, there were two '2-day treatment imposition periods' that had no penguins visible and as a result were removed before any analyses were performed on the animal behavioural state and event data. In other

words, a total of only eight imposition periods out of the 10 were analysed, namely the periods when there were penguins visible.

The 2-day summary values were used as the unit of analysis in all statistical analysis. All animal measurements and ambient noise level were analysed as a five replicate (percentage of penguins visible and in specific areas; FGM; ambient noise), or as a four replicate (animal behavioural states and events), two-treatment analysis of variance (ANOVA) for a fully randomised design. The weather variables were 2-day averages of daily observations from the Greta Point (Wellington) weather station, that is located three kilometres from the Wellington Zoo. A quadratic temporal effect was identified. So, weather variables and/or temporal variables were included as covariates whenever the covariates provided an appreciable improvement to the precision of the statistical analysis. With some penguin measurements, that had more discrete distributions because of low occurrence, the usual test for treatment difference based on the F distribution of the F statistic was replaced by a non-parametric permutation test. The non-parametric permutation used the same F statistic, but the P-value was calculated using permutations of the data values rather than comparing the value with an F distribution (VSN International 2015). Statistical analysis was carried out using the ANOVA directive and APERMTEST procedure of the GenStat 19.1.2 statistical package.

4.4 Results

4.4.1 Visitors

When the penguin exhibit was open to visitors, an average of 200 visitors were observed at the exhibit per day (Table 4.3). Visitors primarily viewed penguins from the visitor viewing pier which had an average of about 76 visitors observed in this area per day and depending on the day, varied from about 10 to 130 visitors (Figure 4.4). The adjacent area to the viewing pier, Path 1, had an average of 71 visitors observed each day and varied from about 30 to 120 visitors, making it the next section most used by visitors to view penguins (Figure 4.4). Path 2 and 3 had an average of 13 and 40 visitors each day, respectively. Visitors also displayed a variety of behaviours when the penguin exhibit was open and the most frequently observed behaviours were walking, looming, loud vocalisations, and sudden movements (Table 4.3). No effect of treatment was found on ambient noise level where the average was about 54 dB for each treatment ($F = 0.83$, d.f. = 1,8, $P > 0.05$).

Table 4.3. The average number of visitors and frequency of visitor behaviours recorded (seven 30 min observation blocks each day) when the little penguin exhibit was open to visitors.

Visitor variables	Average	Standard deviation ^a
<i>Visitor present at the exhibit (per day)</i>		
Total	200	88
Adults	125	64
Children	75	44
<i>Behaviour (Frequency per hour)</i>		
Loud vocalisations	21	16
Looming	32	23
Sudden movement	15	14
Throwing object(s)	0.029	0.090
Standing on ledge	11	8.6
Passively observing	11	5.9
Walking	37	18
Walking on ledge/sign	2.4	2.5
Taking a picture	3.7	3.8
Crouch	1.3	1.4
Entered viewing hide	4.2	4.4
Other	9.8	11

^a Calculated using between day variation.

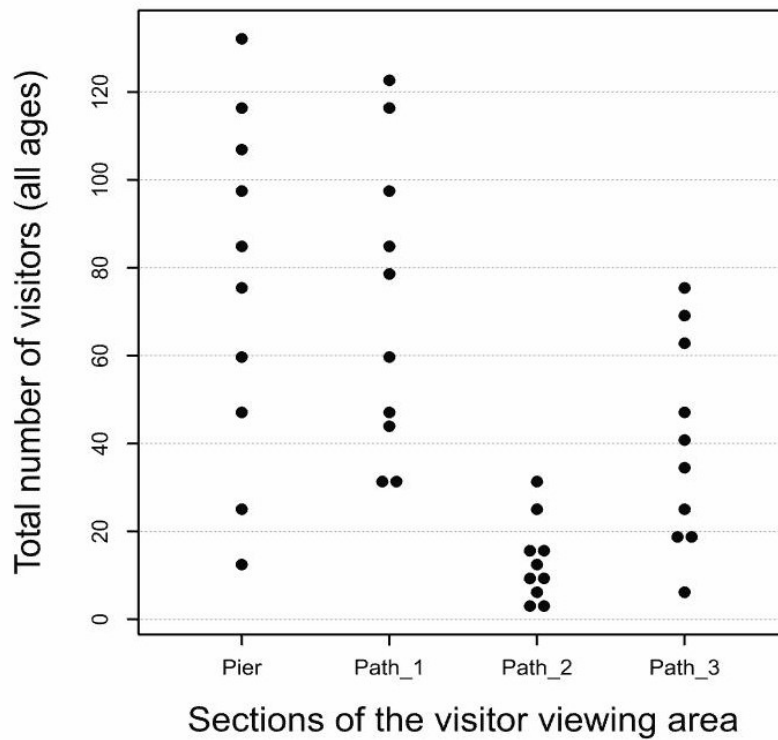


Figure 4.4. Dot histogram of the total number of visitors (all ages) present in each section of the visitor viewing area on days when the penguin exhibit was open. Each dot represents observations from a single day.

4.4.2 Little Penguin behaviour

Depending on the day, the average percentage of penguins visible in Zone 1 varied from 0% to about 54% and varied from 0% to about 35% in Zone 3 (Figure 4.5). The overall average percentage of penguins visible was 17% and 15% when the exhibit was open and closed, respectively (Table 4.4). When the penguin exhibit was closed to visitors, the percentage of penguins observed in Zone 1 increased from about 1% to 9% ($F = 13.83$, d.f. = 1,5, $P = 0.014$) and there was some indication of an increase in Zone 2, (1% to 3%; $F = 5.35$, d.f. = 1,5, $P = 0.069$; Table 4.4). There was no effect of closing the exhibit on other penguin behaviours ($P > 0.05$; Table 4.4 and 4.5).

Table 4.4. Effects of the ‘visitor presence’ and ‘visitor absence’ on the average percentage of penguins visible and location in the enclosure (%).

Penguins visible	Covariates	Angular transformed			Back transformed (%)		P value
		Visitor presence	Visitor absence	s.e.d. ^f	Visitor presence	Visitor absence	
Zone 1	Quadratic temporal variate ^a + Rainfall ^b	6.3	18	3.0	1.2	9.1	0.014^d
Zone 2	Quadratic temporal variate ^a + Rainfall ^b	6.0	10	1.8	1.1	3.1	0.069 ^d
Zone 3		18	11	7.4	9.3	3.6	0.37 ^e
Overall	Quadratic temporal variate ^a	24	23	7.4	17	15	0.88 ^c

Note: No days were excluded for this analysis (i.e. all 10 imposition periods were included, 20 days).

^a Indicates quadratic response to a temporal variate response (1st pair of days (1st experimental unit)=1, 2nd pair of days (2nd experiment unit)=2,..., 10th pair of days (10th experimental unit)=10).

^b Average rainfall for the 2-day treatment imposition periods obtained from Greta Point, Wellington meteorological station.

^c P value was calculated using a F test based on 1 and 6 degrees of freedom.

^d P values were calculated using F tests based on 1 and 5 degrees of freedom.

^e P value was calculate using a F test based on 1 and 8 degrees of freedom.

^fs.e.d. denotes standard error of difference.

Table 4.5. Effects of ‘visitor presence’ and ‘visitor absence’ on the average percentage of visible penguins (%) displaying each behaviour (states and events) and stress physiology.

Penguin behaviour	Covariates	Angular transformed			Back transformed (%)		P value ^b
		Visitor presence	Visitor absence	s.e.d. ^d	Visitor presence	Visitor absence	
<i>States</i>							
Huddling (on land)		24	27	9.6	16	20	0.78
Surface swimming	Rainfall	8.0	25	7.7	1.9	18	0.074
Diving	Windspeed	0.76	1.5	0.78	0.018	0.066	0.54 ^c
Resting (on land)		0.78	2.7	1.2	0.019	0.22	0.18
Idle (on land)	Maximum temperature	58	50	8.0	71	58	0.36
Locomotion (on land)		16	16	3.0	7.7	7.1	0.86
Vigilant (on land)	Maximum temperature	23	19	7.0	15	11	0.60
<i>Events</i>							
Preening (on land)		27	34	4.6	20	31	0.18
Preening (in water)		4.7	8.1	3.5	0.67	2.0	0.38
Allopreen		2.4	2.0	1.3	0.17	0.12	0.77
Agonistic		5.4	5.3	1.8	0.89	0.85	0.95
Bathing		5.6	12.2	5.0	0.95	4.5	0.24
Body Shake (on land)	Rainfall	9.2	8.2	0.73	2.6	2.0	0.26 ^c
Head flick/shake (on land)		15	15	1.5	6.6	6.6	0.97
Beak movement display (on land)		2.8	2.4	2.1	0.24	0.18	0.86
Social interaction		4.2	2.8	1.7	0.53	0.24	0.44
Scratch (on land)		2.2	11	4.2	0.15	3.4	0.090

Scratch (in water)		3.3	7.0	3.2	0.33	1.5	0.290
Other		5.8	4.3	1.1	1.0	0.55	0.23
<i>Stress physiology</i>							
FGM concentration (ng/g)	Quadratic temporal variate ^a + Gust speed	3246	3635	259	-	-	0.19

Note: Two imposition periods were excluded for these analyses, except for FGM concentrations (i.e., only imposition periods where the percentage of penguins visible was greater than 0% were included).

Windspeed (km/h) is the daily vectorial movement of the atmosphere at or near the surface of the land (or sea), averaged over each 2-day period. Gust speed (km/h) is the daily maximum/strongest wind vector, averaged over each 2-day period.

^a Indicates quadratic response to a temporal variate response (1st pair of days (1st experimental unit)=1, 2nd pair of days (2nd experimental unit)=2,..., 10th pair of days (10th experimental unit)=10).

^b *P* values are calculated using F tests based on 1 and 5 degrees of freedom for all measurements with a covariate(s), and 1 and 6 degrees of freedom without a covariate.

^c *P* values calculated using permutation test.

^d s.e.d. denotes standard error of difference.

4.5 Discussion

This experiment examined the effects of visitor presence on zoo-housed little penguins. We found that the percentage of penguins close to the visitor viewing pier (Zone 1) was the only behaviour that was affected by the closure of the exhibit. No effect of visitor presence or absence was found on FGM concentrations. The limited change in behaviour may suggest that visitor presence had minimal or no substantial effect on penguin behaviour. However, the reduced percentage of penguins in Zone 1 when the exhibit was open to visitors indicates that there was increased avoidance of the visitor viewing pier by the little penguins. Since the visitor viewing pier was the main area where visitors viewed the penguins, this finding suggests that the penguins may be fearful of close visitor contact or close visitor viewing proximity. It is well established that avoidance behaviours are an indicator of fear of humans in animals (Hemsworth *et al.* 2018; Sherwen and Hemsworth 2019). Furthermore, previous research has found that little penguins (*Eudyptula novaehollandiae*) in Australian zoos showed increased avoidance of the visitor viewing area when visitors were present, in close viewing proximity or when visual

contact with visitors was unobstructed (Sherwen *et al.* 2015; Chiew *et al.* 2019a; Chiew *et al.* 2020). Zoo-housed African penguins (*Spheniscus demersus*) have also been shown to avoid and decrease time spent in their pool when visitors were present in a pool adjacent to the penguin pool, especially in large numbers (Ozella *et al.* 2014). It has also been found that in the wild, little penguins avoid areas that visitors occupy such as visitor paths and areas of high human traffic (Weerheim *et al.* 2003; Giling *et al.* 2008; Shaughnessy and Briggs 2009). These studies support our interpretation that close visitor contact or viewing proximity may be fear-provoking for the little penguins in the present study.

This avoidance response by the little penguins when visitors were present may be because the visitor viewing pier extended out about 2 m over the pool and thus, positioned visitors on the pier above the level of the penguins in the enclosure. Also, one of the most observed visitor behaviours was looming, particularly at the viewing pier and at the fence line in 'Path 1' which was also in Zone 1. Therefore, visitors positioned above penguins in the enclosure when on the pier and the opportunities to lean on or over the enclosure barriers, may have been perceived as threatening and thus, potentially fear-provoking for the penguins when in Zone 1. As the smallest species of penguins, little penguins have numerous predators including aerial predators (Stahel and Gales 1987). Studies in the wild have also found humans standing over nesting penguins presented more of a threat, similar to an aerial predator, compared to people that kept low or crouched when observing penguins i.e., positioned at penguins' eye level or lower (Nimon 1997; Giese 1998; Holmes *et al.* 2005; Schuster 2010). It is worth noting that there were opportunities in Paths 2 and 3 for visitors to view penguins in close proximity. However, most visitors did not spend much time in these sections of the visitor viewing area, as indicated by the lower visitor numbers observed compared to the Pier and Path 1. This was likely because of vegetation and other structures (e.g., the boat) in the exhibit that obstructed the view between penguins and visitors on Paths 2 and 3.

Of the three experiments conducted by Chiew and colleagues (Chiew *et al.* 2019a; Chiew *et al.* 2020; present experiment), the most marked effects of visitors on penguin behaviours indicative of fear were observed in the experiment at Melbourne Zoo (Chiew *et al.* 2019a) and the present experiment at Wellington Zoo. In the former, closing the exhibit to visitors increased the percentage of visible penguins within 1 m of the main visitor viewing area by 28-fold (from 1% when the exhibit was open to 28% when closed). While in the latter (present experiment), closing the exhibit to visitors increased the percentage of penguins visible in Zone 1 (within 4m of the main visitor viewing area) by 9-fold (from 1% when the exhibit was open to 9% when closed). In the experiment by Chiew *et al.* (2020) at Taronga Zoo, covering the main visitor viewing area window resulted in a slight

increase in the percentage of penguins in the area near this main window, by about 25% (from 12% when the window was uncovered to 15% when covered). In the experiment at Melbourne Zoo, it was also found that restricting visitors from closely approaching the pool increased the percentage of visible penguins within 1m of the main visitor viewing area by about 1300% (from 1% with unrestricted approach to the pool to 14% when close approach was restricted) (Chiew *et al.* 2019a).

Both enclosures at Melbourne and Wellington Zoo when uncontrolled, allowed visitors in the main viewing areas opportunities, if they chose, to closely approach and loom over the pool edge. In contrast at Taronga Zoo, the visitor viewing area was primarily below the level of penguins in the pool and penguins were viewed underwater through tall glass windows. These considerations, together with the differences between zoos in avoidance behaviour from the main visitor viewing area described in the previous paragraph, suggest that the viewing height of visitors relative to the position of the penguins may influence the magnitude of the fear response of penguins. Indeed, as Chiew *et al.* (2019a) have suggested, close approach and looming by visitors are likely to be perceived by little penguins as an aerial predatory threat. However, it should be recognised that there are other differences between these three experiments that may have also influenced the apparent difference in fear responses in little penguins to the uncontrolled presence of visitors at Melbourne Zoo, Wellington Zoo and Taronga Zoo. These differences include aspects of enclosure design, previous experience (e.g., captive bred or wild bred) and genetics as well as the behavioural measurements and behaviour sampling methods, in addition to the differing nature and intensity of visitor interactions in these experiments (Mathews *et al.* 2005; Peucker *et al.* 2009; Conway 2011; Mason *et al.* 2013; Grosser *et al.* 2015; Grosser *et al.* 2016; Grosser *et al.* 2017; Sherwen and Hemsworth 2019).

Like animals in other captive settings, research has shown that enclosures that provide zoos animals with a level of choice and control over the interactions with visitors, for example by providing an area to retreat, can help minimise visitor-induced stress (Owen *et al.* 2004; Ross 2006; Morgan and Tromborg 2007). Wellington Zoo's penguin enclosure was heavily vegetated with Zone 3, hosting physical structures such as most of the vegetation in the enclosure, a partially upturned boat and nest boxes. It is likely that this zone with its structures and distance from the visitor viewing pier, provided both physical and visual separation from most of the visitors. Consequently, the design of Wellington Zoo's penguin enclosure may have helped minimise the intensity of close visitor contact. It also suggests that having viewing features in the exhibit that allow visitors to view penguins in close proximity, may be futile since penguins would move

away and thus, likely reduce visitor viewing experience. As previously mentioned, research in Australian zoos has shown that increased separation between visitors and little penguins reduces penguin fear responses towards visitors and has no detrimental effect on visitor experience (Chiew *et al.* 2019a; Chiew *et al.* 2019b).

FGM concentrations were not affected by treatment which suggests that visitor presence had minimal effect on the overall welfare of the little penguins. One explanation is that a more sustained period of treatment, greater than two days, is required to detect a measurable change in FGM arising from closing the exhibit, similar to that found and suggested by Chiew *et al.* (2019a). It is well established that adrenal activity increases fairly quickly in response to stressors. In little penguins, FGM concentrations increase approximately 7 h after experiencing a stressor (Sherwen and Fanson 2015). However, there is less information about how long it takes for adrenal activity to decrease after a long-term stressor is removed like visitors. Secondly, the opportunity for choice and control over their interactions with visitors, as a result of the design of the enclosure, may have ameliorated the need for the activation of the hypothalamo–pituitary–adrenal axis in little penguins arising from uncontrolled visitor contact.

Several weather variables were found to be useful covariates for improving the precision of the statistical analyses for examining the effects of visitors. This is an indicator that the behaviour and physiology of little penguins were strongly affected by weather. This is not surprising considering the experiment was conducted between the end of Autumn (May) and the start of Winter (June), with the change in seasons generally associated with shifts to lower temperatures and higher rainfall. However, weather reports also showed that Wellington experienced very unsettled weather patterns during the Autumn and Winter of 2018 (Pezza *et al.* 2018a; Pezza *et al.* 2018b). Research on various wild penguin species have shown that colder temperatures can increase sleeping and huddling behaviour; severe rainfall can reduce breeding success and survivability; and increased wind speeds, particularly during storms that cause rough seas with high waves, can decrease activity, foraging success and time spent diving and foraging (Culik *et al.* 1989; Dewasmes *et al.* 2001; Gilbert *et al.* 2008; Demongin *et al.* 2010; Ganendran 2011; Dehnhard *et al.* 2013; Berlincourt and Arnould 2015; Ganendran *et al.* 2016; Saraux *et al.* 2016). Additionally, harsh inclement weather such as blizzards, extreme high and low temperatures, storms, and heavy rain, have been associated with increased corticosterone concentrations in various bird species including penguins (Wingfield *et al.* 1983; de Bruijn and Romero 2013; Thierry *et al.* 2013; Ozella *et al.* 2017; de Bruijn and Romero 2018; Scheun *et al.* 2020). Consequently, further research on the effects of weather on zoo-housed little penguin behaviour and physiology is required.

In our research across two Australian zoos and now a zoo in New Zealand, we have found there are some common characteristics of visitor contact that zoo-housed little penguins may find fear-provoking. These characteristics include close visitor contact or the close viewing proximity of visitors (Sherwen *et al.* 2015; Chiew *et al.* 2019a; Chiew *et al.* 2020). While having close contact with penguins including close human contact from above may be beneficial for the viewing experience of visitors, these characteristics of visitor contact may increase the likelihood of potentially threatening visitor behaviours occurring (e.g., banging on enclosure features, looming behaviour, and sudden movement). As a result, visitors are more likely to be perceived as threatening and thus, increase little penguins' fear responses (Sherwen *et al.* 2015; Chiew *et al.* 2019a; Chiew *et al.* 2020). These characteristics of human contact are also consistent with studies on other species of zoo-housed penguins and wild penguins (Klomp *et al.* 1991; Wienecke *et al.* 1995; Nimon 1997; Giese 1998; Weerheim *et al.* 2003; Holmes *et al.* 2005; Giling *et al.* 2008; Shaughnessy and Briggs 2009; Schuster 2010; Ozella *et al.* 2014).

Close visitor contact may be mitigated by positioning visitors further away from the enclosure boundary or by reducing the perceived close proximity of visitors in little penguins (Chiew *et al.* 2019a; Chiew *et al.* 2020). This highlights some important practical measures that should be considered to manage visitor-penguin interactions in both zoo and wild settings. For example, increased separation between visitors and little penguins, whether that be by using a physical barrier to push visitors back from the enclosure or designing enclosures in a way that allows for this (Chiew *et al.* 2019a). Zoos can also consider reducing the perception of the close viewing proximity of visitors by positioning visitors below penguins, by providing areas for penguins that are visually hidden from visitors or by using one-way viewing windows (Chiew *et al.* 2020). These practical measures can ultimately result in the improvement in the welfare of penguins as well as have no detrimental effect on visitor viewing experience (Chiew *et al.* 2019a; Chiew *et al.* 2019b; Chiew *et al.* 2020). However, the effectiveness of one-way viewing windows to regulate visitor-penguin interactions to improve the welfare of penguins without negatively affecting visitor experiences has not yet been experimentally examined, and thus requires further investigation. This can be examined in aquarium settings which, like many zoos, commonly house various penguin species and utilised glass viewing windows.

4.6 Conclusions

Little penguins (*Eudyptula minor*, *Kororā*) at Wellington Zoo showed an avoidance of the visitor viewing pier when the exhibit was open to visitors which suggests that these penguins may be fearful of close visitor viewing proximity. These results suggest viewing features that are designed to allow close viewing proximity, such as piers overhanging the exhibit, may be ineffective in improving visitor experience since little penguins are likely to avoid these features when visitors are present. This avoidance of visitors may be exacerbated by visitors being perceived as a predator while on viewing features that position visitors close to and above the penguins. Consequently, zoos exhibiting little penguins should design the enclosure and visitor viewing areas so that visitors are set back from the enclosure boundary or by obscuring the penguins' view of visitors to minimise the potential fear responses of the penguins to zoos visitors.

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Chapter 5

The effect of regulating zoo visitor-penguin interactions on zoo visitor attitudes.

This chapter examines the relationship between penguin behaviour and visitor attitudes and the effects of regulating the interactions between zoo visitors and zoo-housed little penguins on visitor attitudes and experience.



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5.1 Abstract

Understanding visitor attitudes towards zoo animals can inform the way zoos manage visitor-animal interactions by identifying the factors that may influence visitors and the way visitors interact with animals. Consequently, we investigated the relationship between visitor attitudes and penguin behaviour and the effects of regulating visitor-penguin interactions on visitor attitudes and experience. Visitor attitudes towards little penguins (*Eudyptula minor*), their welfare, enclosure, visitor effects, enclosure manipulations and visitor experience at an Australian zoo were assessed. A 2×2 fully randomized factorial design was used to examine potential factors that may influence visitor attitudes: 1. Viewing proximity of visitors to the enclosure: 'Normal viewing distance' and 'Increased viewing distance' (using a physical barrier set up 2 m from the enclosure) and 2. Intensity of visitor behaviours: 'Unregulated visitor behaviour' and 'Regulated visitor behaviour' (using signage and researcher in zoo uniform). Visitor attitudes were assessed using an anonymous attitude questionnaire. Visitors were approached after they had finished viewing the penguins and were given two options to complete the questionnaire, either on an iPad on site during their zoo visit or online (URL sent via email) after their zoo visit. A total of 495 surveys (48% during zoo visit, 52% after zoo visit) were completed. Majority of respondents were non-zoo members, females and aged between 26-35 years old. Results revealed a significant relationship ($p < 0.05$) between little penguin behaviour and visitor attitudes where the more visible, active, and close penguins were to the visitor viewing area, the more positive several visitor attitude scales were. In contrast, there were only a few treatment effects of regulating visitor viewing proximity and behaviour on visitor attitudes in which attitudes towards 'Positive penguin characteristics' ($p = 0.024$), 'Neutral visitor effects' ($p = 0.0023$) and 'Physical barriers' ($p = 0.013$) were affected. This suggests that physical barriers and/or signage are factors that influence visitor attitudes. However, it is unclear if the treatment effects influenced visitor attitudes directly, or if it was the changes in penguin behaviour as a consequence of the treatments that were associated with visitor attitudes. These findings have increased our understanding of the multifaceted nature of visitor attitudes and have identified some influencing factors on attitudes that can be used to inform the way zoos manage visitor-penguin interactions, but clearly further research is required.

Keywords: visitor attitudes, visitor-animal interactions, zoos, little penguins, penguin behaviours, exhibit manipulations.

5.2 Introduction

Understanding zoo visitor perceptions and attitudes has been of growing importance because of the varying effects zoo visitors can have on the behaviours and welfare of zoo animals (Hosey, 2013; Sherwen and Hemsworth, 2019). In particular, understanding visitor attitudes towards zoo animals can inform the way zoos manage visitor-animal interactions by identifying the factors that may influence visitors and the way they interact with animals. However, this has yet to be established and thoroughly investigated within zoos (Fernandez et al., 2009; Hosey, 2013; Sherwen and Hemsworth, 2019). Before proceeding further, it is important to define what we mean by ‘perceptions’ and ‘attitudes’ as these two terms are often used interchangeably. On the one hand, while closely related to attitudes, perceptions refers to an individual’s interpretation of specific situations, stimuli, or objects into something meaningful to them based on past experiences (Pickens, 2005). On the other hand, attitudes refer to the “mindset or tendency to act in a certain way” where we are trying to understand or explain an individual’s behaviours (Pickens, 2005). Therefore, attitudes are reflective of a positive or negative assessment of a given object which are derived from beliefs (Ajzen, 1991; Eagly and Chaiken, 1993) and are a strong determinant of behaviours (Ballantyne and Parker, 2005).

Research on zoo visitors has shown that there are a variety of factors that influence visitor perceptions of zoos, zoo animals, visitor experience, viewing times and interests including exhibit design and animal characteristics such as animal size, colour, activity, and rarity (Rhoads and Goldsworthy, 1979; Bitgood et al., 1988; Finlay et al., 1988; Reade and Waran, 1996; Nakamichi, 2007; Margulis and Westhus, 2008; Kutska, 2009; Whitworth, 2012; Mun et al., 2013). However, despite this growing research and evidence of visitor effects on zoo animals, we have limited understanding of visitor attitudes towards specific zoo species, what influences these attitudes and how these attitudes affect visitor behaviours, and the way visitors interact with zoo animals (Fernandez et al., 2009; Hosey, 2013; Sherwen and Hemsworth, 2019). Understanding visitor attitudes towards specific zoo species and the factors, such as animal behaviours, that may influence these attitudes, are important because of the potential implications they can have on the way zoos manage visitor-animal interactions. Research on zoo visitor-animal interactions has shown that these interactions can affect both zoo animal welfare and visitor experience and thus, visitor perceptions of zoos and zoo animals (Sherwen and Hemsworth, 2019). Negative visitor perceptions can adversely impact the mission of zoos of providing high standards of animal welfare and positive visitor experiences to support zoos as zoo-based

conservation organizations (Ward and Sherwen, 2018; Sherwen and Hemsworth, 2019). Consequently, it is vital for zoos to not only understand how visitors affect zoo animals but also visitor attitudes towards specific zoo species and how potential factors such as zoo animal behaviours may affect visitor attitudes. Through this understanding, zoos can then target these attitudes to potentially modify visitor behaviours towards zoo animals to better manage visitor-animal interactions. However, limited research has been conducted to understand this relationship between visitor attitudes and zoo animal behaviours.

Godinez et al. (2013) is one of the few studies that has investigated the influence of zoo animal behaviours on both visitor behaviours and visitor perceptions of the animal. They found that crowd size and visitor length of stay increased when jaguars were visible regardless of whether animals were active (e.g., eating, walking), inactive (sitting or lying down) or engaged in stereotypic behaviours (e.g., pacing and circling) compared to when “out of sight” (Godinez et al., 2013). However, visitor perceptions of the jaguars’ wellbeing were reduced when the jaguars were displaying stereotypic behaviours (Godinez et al., 2013). This study highlights how animal behaviours can influence visitor perceptions, but it remains unclear whether animal behaviours influence visitor behaviours as no comparisons were made between active, inactive, and stereotypic behaviours on visitor dwell time. Also, Miller (2012) found that after viewing a short video of a tiger engaged in pacing behaviours compared to a tiger resting, people’s perception of the level of care for the tigers at the facility decreased as did their interest in supporting zoos. It is evident from these studies, that there is a need for more robust research investigating how animal behaviours affects visitor attitudes towards zoo animals and subsequently visitor behaviours. Ideally, an experimental approach should be taken whereby the interactions between visitors and animals are manipulated. Doing so, allows for causal conclusions to be drawn which enables rigorous interpretation of the effects of manipulating visitor-animal interactions on visitors and zoo animals (Cochran and Cox, 1957). Only a handful of studies thus far have applied this type of experimental approach to study zoo visitor-animal interactions (e.g. Sherwen et al., 2014; Sherwen et al., 2015a; Sherwen et al., 2015b; Learmonth et al., 2018; Chiew et al., 2019). For example, Saiyed et al. (2019) found that zoo-housed African penguins (*Spheniscus demersus*) entering a close encounter with visitors in their enclosure in which visitors were instructed to sit quietly on a bench, showed no subsequent changes in affiliative and aggressive behaviours in comparison to no close encounter. While Sherwen et al. (2015b) and Chiew et al. (2019) found that close visitor contact markedly affected huddling, vigilance, pool use, proximity to the visitor viewing area and preening behaviours of little

penguins (*Eudyptula minor*) which suggests that visitors looming over penguins rather than sitting may be more fear-provoking. This type of research can help inform the way zoos manage visitor-animal interactions and may require, for example, alterations in exhibit design or the development of interventions to optimize both animal welfare and visitor attitudes and experience. Consequently, it is also important to evaluate the effects of interventions or management strategies that may be used to manage these interactions on visitors and animals.

Some studies have found that modification of zoo visitor-animal interactions using interventions or manipulations in the exhibit area such as visual or physical barriers, may affect visitor experience and potentially visitor attitudes despite the improvement in animal welfare. For example, the presence of a one-way visual screen that reduced the visibility of visitors resulted in reductions in intragroup aggression and faecal glucocorticoid concentrations in black-capped capuchin (*Sapajus apella*) (Sherwen et al., 2015a). This indicated an improvement in capuchin welfare but was found to reduce visitor numbers at the exhibit, perhaps because of the reduced interaction with the capuchins and in turn potentially reduced visitor experience and interest in the exhibit (Sherwen et al., 2015a). Also, Chiew et al. (2019) found that regulating visitor viewing proximity and the intensity of visitor behaviours by using a physical barrier to increase visitor viewing distance by 2 m away from the enclosure, reduced little penguin (*Eudyptula minor*) fear responses towards visitors. This was indicated by a reduction in the frequency of potentially threatening visitor behaviours such as banging on enclosure features, looming over the pool and sudden movement which reduced the proportion of penguins huddling and vigilant and increased the proportion of penguin close to the visitor viewing area, surface swimming and preening in the water when the physical barrier was in place (Chiew et al., 2019). However, the physical barrier was found to reduce visitor numbers, similar to that of Sherwen et al. (2015a). In contrast, Blaney and Wells (2004) found that when camouflage netting was installed to the viewing area of a gorilla exhibit that reduced the visibility of visitors, it not only improved gorilla welfare but also improved visitor perceptions of the gorillas. Consequently, assessing visitor attitudes towards such interventions and management strategies is important so that zoos can balance animal welfare and visitor experience and feasibly manage visitor-animal interactions.

Our present study was conducted in conjunction with that of Chiew et al. (2019). Our aims were to examine the relationships between visitor attitudes and experience and penguin behaviours and determine the effects of regulating visitor viewing proximity and behaviours on visitor attitudes and experience.

5.3 Methodology

Visitor attitudes towards little penguins were studied in conjunction with our study that investigated the effects of regulating visitor viewing proximity and the intensity of visitor behaviours on little penguin behaviours and stress physiology (Chiew et al., 2019). Thus, this present study was conducted using the same methodology as Chiew et al. (2019) at the Melbourne Zoo little penguin (*Eudyptula minor*) exhibit (Zoos Victoria, Australia) which housed a breeding group of 15 little penguins in an outdoor, naturalistic 330m² enclosure consisting of sand and vegetation areas, and a large swimming pool that went up to 3 m in depth (Figure 5.1). The enclosure walls were 1.2 m in height and the visitor path ran along three sides of the enclosure in which the main penguin viewing positions were along the length of the pool, side A, but opportunities to view penguins also occurred on the short ledge of the pool, side B (Figure 5.1). The penguins were fed twice a day (9:00 and 15:30 h) and husbandry followed normal routines and remained consistent throughout the course of the study (Chiew et al., 2019).

5.3.1 Design and Treatments

A 2×2 factorial treatment arrangement was used to examine the combined effects of regulating both visitor viewing proximity and intensity of visitor behaviour on penguins (Chiew et al., 2019) and visitor attitudes and experience. The factors that were examined were as follows (Chiew et al., 2019):

1. **Viewing proximity of visitors to enclosure** at 2 levels:
 - a. '*Increased viewing distance*' – a barrier was set up 2 m from the enclosure to increase the distance between visitors and the enclosure. This allowed unrestricted viewing of the enclosure but was a strong impediment to visitors physically interacting with the glass windows at the pool, pool water and other enclosure features.
 - b. '*Normal viewing distance*' – no barrier was in place and visitors could approach to the edge of the pool (i.e., visitors could approach within 2 m of the enclosure).
2. **Intensity of visitor behaviours** at 2 levels:
 - a. '*Unregulated visitor behaviour*' – visitor behaviours were uncontrolled.
 - b. '*Regulated visitor behaviour*' – the objective of this treatment was to attempt to reduce the intensity of visitor behaviour using signs requesting visitors to be quiet, move slowly in the exhibit area and avoid physically interacting with the penguins. Also, for this treatment, the researcher was dressed in zoo uniform.

Thus, there were four treatments in a factorial design as described in Table 5.1. For further details and description of the design and treatments imposed refer to Chiew et al. (2019).

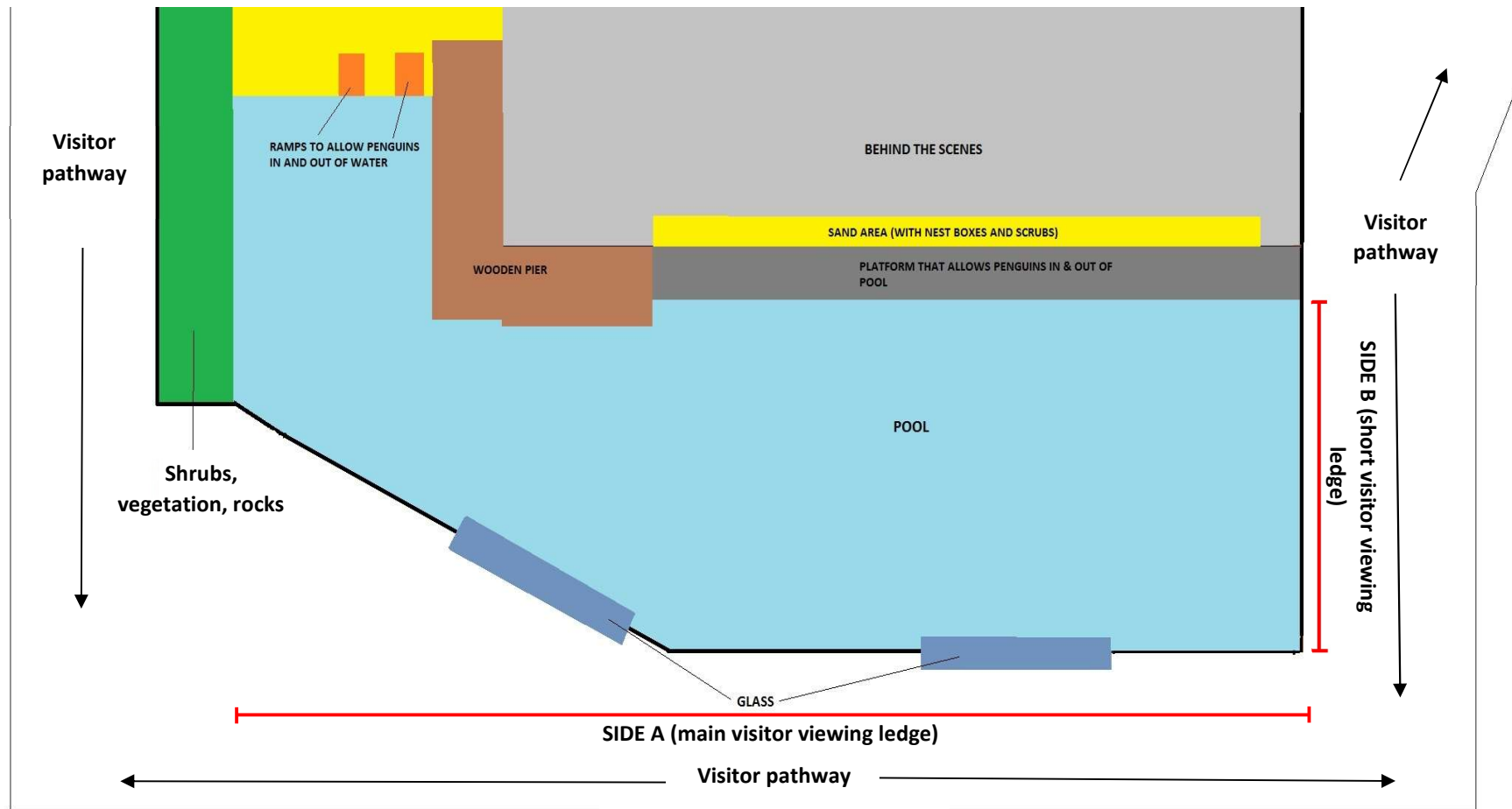


Figure 5.1. Diagram of Melbourne Zoo penguin exhibit obtained from Chiew et al. (2019).

Table 5.1. The 2x2 factorial treatment arrangement used to examine the combined effects of visitor viewing proximity (using a physical barrier to push visitors 2 m back from the enclosure) and the intensity of visitor behaviours (using signage to attempt to regulate visitor behaviours) on penguins and visitor attitudes and experience.

FACTORS		Intensity of visitor behaviours	
		<i>Unregulated visitor behaviours</i>	<i>Regulated visitor behaviours</i>
Visitor viewing Proximity	<i>Normal viewing distance</i>	No physical barrier and no signs (Control)	No physical barrier but signs present (Signs)
	<i>Increased viewing distance</i>	Physical barrier present but no signs (Physical barrier)	Physical barrier and signs present (Physical barrier & Signs)

Using a fully randomised factorial design, treatments were randomly imposed for 2-day periods, two treatments per week with one day break in between (Mon-Tues and Thurs-Fri) and three replicates of each treatment (total of 24 study days). The study was conducted from the end of February to May 2016 (Summer/Autumn) over 9 weeks and was only conducted on school working days, to avoid the normal systematic variation in visitor numbers that occurs on weekends and during school holiday periods (Chiew et al., 2019). Two out of the 9 weeks had treatments with no day break in between which was due to public holidays occurring on the Monday one week and Friday the other week (Chiew et al., 2019).

The main penguin behaviour measurements used from Chiew et al. (2019) for the present study were the behavioral states of the penguins including the proportion of penguins visible, huddling, distance from the visitor viewing area (side A and B; Figure 5.1), resting, idle, locomoting on land, vigilant, surface swimming and diving. For further information on the behavioral sampling procedure refer to Chiew et al. (2019).

5.3.2 Visitor questionnaires

This study received Human Ethics approval from the Veterinary and Agricultural Sciences Human Ethics Advisory Group (Ethics Application 1545739.1). Questionnaires were developed and refined based on focus groups discussions with visitors at Melbourne Zoo (Melbourne, Australia) and Taronga Zoo (Sydney, Australia).

Visitors were randomly approached by student volunteers and interns (from the Animal Welfare Science Centre, University of Melbourne) during seven 30 min blocks between 09:30–

15:15 h, after they had finished viewing the penguins and had exited the exhibit area. Visitors were asked to complete an anonymous questionnaire which assessed their attitudes towards the welfare of little penguins, the quality of their exhibit, exhibit manipulations and visitor experience. Visitors were given two options to complete the questionnaire, either on an iPad (on site during their zoo visit) or online (URL sent via email, after their zoo visit). Questionnaires were conducted on all study days.

Questionnaires took no longer than 10 minutes to complete and were divided into five sections: Section 1 collected information on the participant's demographics; Section 2 collected information on the participant's attitudes towards the little penguins and included questions such as "Do you think the little penguins are aggressive?", "Do you think the penguins are happy?" and "On a scale from 1-10, how would you rate the welfare of the little penguins"; Section 3 collected information on the participant's attitudes towards the little penguin enclosure and included questions such as "Do you think the penguin enclosure is well maintained?" and "On a scale from 1-10, how would you rate the little penguin enclosure?"; Section 4: collected information on the participant's experience where for example, questions in this section included "It was exciting to see the little penguins." and "On a scale from 1-10, how would you rate your experience at the penguin enclosure?"; and the final section assessed the participants' attitudes towards manipulations to the little penguin enclosure which included questions such as "Having one-way visual barriers where penguins cannot see visitors but visitors can see penguins improves penguin welfare.". For attitude questions, a five-point Likert scale was used which consisted of the following options: 1. Strongly disagree, 2. Disagree, 3. Neither agree nor disagree, 4. Agree and 5. Strongly agree. The responses were scored so that disagreement with a statement had lower scores and agreements had higher scores. For rating questions, visitors were asked to rate, out of 10, the welfare of the little penguins, the little penguin enclosure and visitor experience at the enclosure where 1 was very poor and 10 was excellent.

A plain language statement was also visible at the enclosure and areas in which student volunteers and interns were located. The purpose of the plain language statement, which is a requirement for human ethics approval by the university, was to provide visitors with details and the purpose of the survey.

5.3.3 Data Analysis

Statistical analyses of questionnaire responses comprised frequency distributions of demographic factors across response categories and principal component analyses (PCAs) on attitudinal data using SPSS version 25. PCAs were conducted on the attitudinal data from the questionnaire to reduce the large number of attitude variables to a relatively small number of components, where the components reflected commonalties amongst those individual

variables that correlated highly with each other. Subjective labelling of each component based on semantic content of the items was performed. Cronbach alphas (α) were performed to measure the internal consistency of the items/questions within each component extracted from PCA (i.e., how closely related a set of items were as a group) as a measure of scale reliability. Scale mean scores for each component were calculated so that the averages were on the same scale as the original items/questions i.e., Likert scale from 1 to 5. Scale mean scores were then used as dependent variables for subsequent statistical analyses including one-way analysis of variance (ANOVA) to identify differences between treatments on scale mean scores. Prior to these ANOVAs, Levene's test statistic was used to test for homogeneity of variance.

The data on the effects of regulating visitor viewing proximity and behaviours on penguin behaviours from Chiew et al. (2019), were obtained at the same time as questionnaire responses were collected. Pearson correlations were used to examine the relationship between visitor attitudes and penguin behaviours where scale mean scores for each day for visitor attitudes and the angular transformed data per day for penguin behaviours were used i.e., the proportion of penguins performing each behaviour per day (%). This transformation was used so that the residual variation was similar in all treatments and average scale mean scores were calculated per day as penguin behaviours was averaged per day. It should be noted that the penguin behaviours in Chiew et al. (2019) was averaged across the 2-day period for each treatment whereas single day averages were used in the present study because different visitors were surveyed each day.

5.4 Results

5.4.1 Demographics and percentage of respondents

A total of 495 visitors completed the questionnaire and 639 visitors refused to complete the questionnaire; 238 were completed onsite (48%) during their zoo visit while 257 were completed online after their zoo visit (52%). Most participants were visitors living in Australia, non-zoo members and primarily females (Table 5.2). Also, majority of respondents were pet owners or had previously owned a pet and were aged between 26-35 years old (Table 5.2). Furthermore, most participants' highest level of education was a university or higher education institution degree (Table 5.2). There was a fairly even spread of participants across the four main study treatments, however the 'Physical barrier' treatment which increased visitor viewing distance from the penguin enclosure by 2 m to regulate visitor viewing proximity, had the highest percentage of surveys completed on those days (Table 5.2).

Table 5.2. Demographic information on visitors who completed the questionnaire.

Demographic Factor	Control (standard zoo conditions)	Physical barrier	Signs	Physical barrier & Signs	Total
Number of participants	114 (23.0%)	167 (33.7%)	91 (18.4%)	123 (24.8%)	495
<i>Residence</i>					
Living in Australia	87	127	82	96	392 (80.0%)
Overseas	26	38	9	25	98 (20.0%)
<i>Type of visitor</i>					
Zoo member	54	77	42	48	221 (44.6%)
Non-zoo member	60	90	49	75	274 (55.4%)
<i>Gender</i>					
Male	30	51	29	39	149 (30.0%)
Female	84	116	61	84	345 (69.8%)
<i>Previously owned/Currently own a pet</i>					
Yes	104	157	85	117	463 (93.5%)
No	10	10	6	6	32 (6.5%)
<i>Age</i>					
18-25	30	40	14	35	119 (24.2%)
26-35	29	51	31	33	144 (29.3%)
36-45	30	45	23	27	125 (25.4%)
46-55	6	9	7	9	31 (6.3%)
55+	19	21	15	18	73 (14.8%)
<i>Highest Level of Education</i>					

No formal schooling	0	0	0	0	0 (0%)
Primary school	0	0	1	0	1 (0.2%)
Secondary school	19	27	17	27	90 (18.2%)
Technical or further education institution (including TAFE College)	21	32	19	18	90 (18.2%)
University or other higher education institution	74	108	53	74	309 (62.4%)
Other educational institution	0	0	1	4	5 (1.0%)

5.4.2 Principal component analyses (PCA)

There were 46 attitudinal statements that were subjected to PCA (Table 5.3). Scale reliabilities were measured using Cronbach's α coefficients with an $\alpha \geq 0.70$ as the criterion for acceptable reliability (Pallant, 2007). Items were included in a scale if their loading on the relevant component exceeded 0.33 (Pallant, 2007; Tabachnick and Fidell, 2007) and if, based on face validity and semantic content, they could be summarized by just one construct. Varimax or oblimin rotations were performed on component solutions of more than one factor to provide the best simple structure and to simplify interpretation (Pallant, 2007). Selection of a varimax or oblimin rotation was also determined by examining the 'component correlation matrix'. If the correlations between components in this matrix were greater than 0.30, which indicates there is more than 10% overlap in variance between the components and therefore suggests they are correlated (Pallant, 2007; Brown, 2009), an oblimin rotation was used. If the correlations in the 'component correlation matrix' did not exceed 0.30, then a varimax rotation was performed.

The greater the loading, the more the variables are a pure measure of the factor/component; loadings above 0.70 are considered strong/excellent (Tabachnick and Fidell, 2007). Table 5.3 provides the extracted attitude components, the questions that loaded on each component and the scale mean scores for each component where the higher the mean score, the more

agreement and therefore more positive the attitude. Cronbach's α coefficients are also presented in Table 5.3.

5.4.2.1 Attitudes towards little penguin

A total of 7 attitude questions were subjected to PCA. The Kaiser-Meyer-Olkin value was 0.86 and Bartlett's test of sphericity was significant ($p < 0.05$). No rotation was performed as only a single component was extracted with eigenvalues exceeding 1. The component explained a total of 53.3% of the variance. Based on an inspection of the loadings, the component was labelled as "*Positive penguin characteristics*" (Table 5.3). Single questions related to little penguin aggressiveness and timidity were analysed separately as they were found to not reliably measure the same underlying construct when subjected to PCA.

5.4.2.2 Attitudes towards little penguin welfare

A total of 12 attitude questions were subjected to PCA. The Kaiser-Meyer-Olkin value was 0.88 and Bartlett's test of sphericity was significant ($p < 0.05$). The PCA extracted two main components with eigenvalues exceeding 1. The two components explained a total of 54.0% of the variance; component 1 explained 42.0% and component 2 explained 12.0% of the variance. An oblimin rotation was used and the two components had a correlation of -0.49. Based on an inspection of the loadings observed in the Pattern matrix, component 1 was labelled "*Negative penguin welfare*" and component 2 labelled "*Positive penguin welfare*" (Table 5.3). Also, the question where visitors were asked to rate the welfare of the little penguins (out of 10) was analysed separately as it was on a different rating scale to the attitudinal statements. Overall, visitors rated little penguin welfare on average as 7.60 out of 10 (minimum=3, maximum=10).

5.4.2.3 Attitudes towards the visitor effect

A total of 5 attitude questions were subjected to PCA. The Kaiser-Meyer-Olkin value was 0.60 and Bartlett's test of sphericity was significant ($p < 0.05$). The PCA extracted only two main components with eigenvalues exceeding 1. A varimax rotation was used. The two components explained a total of 70.5% of the variance; component 1 explained 43.5% and component 2 explained 27.0% of the variance.

Based on an inspection of the loadings, component 1 was labelled "*Positive visitor effects*" and component 2 was labelled "*Neutral visitor effects*" (Table 5.3). Cronbach's α for "*Neutral visitor effects*" was 0.57 which was below the criterion of 0.70 (Table 5.3). This was influenced by only two items loading on this component but the Cronbach's α was deemed adequate based on the item loadings being above 0.70 and this component explained 27.0% of the variance.

5.4.2.4 Attitudes towards the little penguin enclosure

A total of 9 attitude questions were subjected to PCA. The Kaiser-Meyer-Olkin value was 0.89 and Bartlett's test of sphericity was significant ($p < 0.05$). The PCA extracted two main components with eigenvalues exceeding 1. An oblimin rotation was used in which the components had a correlation of -0.55. The two components explained a total of 67.8% of the variance; component 1 explained 56.1% and component 2 explained 11.7% of the variance. Based on an inspection of the loadings, component 1 was labelled "*Positive enclosure features*" and component 2 "*Negative enclosure features*" (Table 5.3). Also, a question where visitors were asked to rate the little penguin enclosure (out of 10) was analysed separately as it was on a different rating scale to the attitudinal statements. Overall, visitors rated the little penguin enclosure on average as 6.91 out of 10 (minimum=1, maximum=9).

5.4.2.5 Attitudes towards visitor experience

A total of 9 attitude questions were subjected to PCA. The Kaiser-Meyer-Olkin value was 0.78 and Bartlett's test of sphericity was significant ($p < 0.05$). The PCA extracted three components with eigenvalues exceeding 1. A varimax rotation was used. The three components explained a total of 71.4% of the variance; component 1 explained 38.8% and component 2 and 3 explained 20.9% and 11.8% of the variance respectively.

Based on an inspection of the loadings, component 1 was labelled "*Learning*", component 2 "*Experience*" and component 3 "*Interests*" (Table 5.3). Cronbach's α for "*Interests*" was 0.45 which was below the criterion of 0.70 (Table 5.3). This was influenced by only two items loading on this component but the Cronbach's α was deemed adequate because both item loadings were above 0.70 and this component explained 11.8% of the variance. Also, a question where visitors were asked to rate their experience (out of 10) at the little penguin enclosure was analysed separately as it was on a different rating scale to the attitudinal statements. Overall, visitors rated their experience at the little penguin enclosure on average as 6.45 out of 10 (minimum=1, maximum=9).

5.4.2.6 Attitudes towards exhibit manipulations

A total of 4 attitude questions were subjected to PCA. The Kaiser-Meyer-Olkin value was 0.59 and Bartlett's test of sphericity was significant ($p < 0.05$). Although, the scree plot indicated only one eigenvalue exceeding 1, two components with an oblimin rotation provided a more interpretable result. The two components had a correlation of 0.32 and explained a total of 74.9% of the variance; component 1 explained 50.8%, and component 2 explained 24.0%.

Based on an inspection of the loadings, component 1 was labelled "*Visual barriers*" and component 2 was labelled "*Physical barriers*" (Table 5.3). Cronbach's α for "*Physical barriers*"

was 0.52 which was below the criterion of 0.70 (Table 5.3). This was influenced by only two items loading on this component but the Cronbach's α was deemed adequate because the item loadings were above 0.70 and the variance explained was 24.0% for this component.

Table 5.3. Extracted attitude components from performing PCAs with the corresponding survey questions that loaded on the component, their loadings and scale mean scores ($\pm$ standard error of mean, SEM) based on a 5-point Likert scale (1=strongly disagree to 5=strongly agree).

Extracted attitude components	Items	Loadings	Scale mean scores $\pm$ SEM
Positive little penguin characteristics (Cronbach's $\alpha = 0.85$)	Do you think little penguins are Playful?	0.80	3.71 $\pm$ 0.03 (n=473)
	Do you think little penguins are Curious?	0.78	
	Do you think little penguins are Intelligent?	0.75	
	Do you think little penguins are Interactive?	0.75	
	Do you think little penguins are Proactive?	0.71	
	Do you think little penguins are Friendly?	0.70	
	Do you think little penguins are Social?	0.60	
Negative penguin welfare (Cronbach's $\alpha = 0.84$)	Do you think the penguins are Frightened?	0.88	2.66 $\pm$ 0.03 (n=467)
	Do you think the penguins are Stressed?	0.85	
	Do you think the penguins are Frustrated?	0.73	
	Do you think the penguins are Anxious?	0.68	
	Do you think the penguins are Subdued?	0.66	
	Do you think the penguins are Bored?	0.56	
	Do you think the penguins are Under-stimulated?	0.47	
Positive penguin welfare (Cronbach's $\alpha = 0.78$)	Do you think the penguins are Alert?	0.89	3.70 $\pm$ 0.03 (n=466)
	Do you think the penguins are Healthy?	0.82	
	Do you think the penguins are Happy?	0.74	
	Do you think the penguins are Expressing natural behaviours?	0.62	
	Do you think the little penguins are Calm?	0.40	
	Do you think penguins find visitors entertaining?	0.89	

Positive visitor effects (Cronbach's $\alpha = 0.78$)	Do you think penguins find visitors interesting?	0.88	2.82±0.03 (n=474)
	Do you think penguins find visitors novel?	0.72	
Neutral visitor effects (Cronbach's $\alpha = 0.59$)	Do you think penguins find visitors NOT fear-provoking?	0.86	3.21±0.03 (n=472)
	Do you think penguins are unbothered by visitors?	0.82	
Positive enclosure features (Cronbach's $\alpha = 0.87$)	Do you think the penguin enclosure is interesting to look at?	0.85	3.39±0.03 (n=477)
	Do you think the penguin enclosure is well maintained?	0.84	
	Do you think the penguin enclosure is natural looking?	0.82	
	The exhibit was engaging.	0.68	
	Do you think the penguin enclosure is meeting the needs of penguins?	0.54	
	Do you think the penguin enclosure is NOT bland?	0.43	
Negative enclosure features (Cronbach's $\alpha = 0.87$)	Do you think the penguin enclosure is small?	0.93	2.92±0.04 (n=481)
	Do you think the penguin enclosure is restrictive?	0.91	
	Do you think the penguin enclosure is NOT spacious?	0.71	
	Do you think the penguin enclosure is bland?	0.45	
Learning (Cronbach's $\alpha = 0.88$)	Do you think the penguin enclosure is NOT meeting the needs of penguins?	0.34	2.79±0.04 (n=479)
	I learnt about a penguin's natural lifestyle.	0.89	
	I learnt about penguin behaviours when I was at the penguin exhibit.	0.88	
	I learnt about conservation issues related to penguins.	0.87	
	I like being close to the penguins.	0.81	

Experience (Cronbach's $\alpha = 0.81$)	I like seeing the penguins active and engaging in lots of behaviours.	0.78	3.96±0.03 (n=482)
	It was exciting to see the little penguins.	0.77	
	It was entertaining to watch the little penguins.	0.74	
Interests (Cronbach's $\alpha = 0.45$)	I wish there was more information about the penguins at the exhibit.	0.83	3.77±0.03 (n=477)
	If I could, I would like to do something to help care for little penguins in captivity and in the wild.	0.75	
Visual barriers (Cronbach's $\alpha = 0.76$)	Having one-way visual barriers where penguins cannot see visitors, but visitors can see penguins improves penguin welfare.	0.90	3.68±0.04 (n=481)
	Having one-way visual barriers where penguins cannot see visitors, but visitors can see penguins improves visitor experience.	0.88	
Physical barriers (Cronbach's $\alpha = 0.52$)	Having physical barriers that reduce the proximity between visitors and penguins improves visitor experience.	0.92	3.47±0.03 (n=478)
	Having physical barriers that reduce the proximity between visitors and penguins improves penguin welfare.	0.69	

5.4.3 Relationship between little penguin behaviours and visitor attitudes

Little penguin behaviours were found to be significantly correlated ($p < 0.05$) with all attitude scale mean scores, except for 'Perceived Aggressiveness' and 'Interests' (Table 5.4). The majority of the correlations fell within the moderate range, 0.40-0.59, with a few in the strong range, 0.60-0.79 (Table 5.4; Evans, 1996).

'Positive penguin characteristics' were positively correlated with penguins close to the visitor viewing area, surface swimming and diving and negatively correlated with penguins idle (Table 5.4). This was also observed for 'Experience' (Table 5.4). Similarly, 'Positive penguin welfare' was positively correlated with the proportion of penguin visible, surface swimming and diving and negatively correlated with the proportion of penguins idle. This was also found for 'Positive enclosure characteristics' which was also negatively correlated with the proportion of penguins locomoting (Table 5.4). In contrast, 'Negative penguin welfare' were negatively correlated with proportion of penguins visible, close to the visitor viewing area,

surface swimming and diving and positively correlated with penguins locomoting which was also observed for 'Negative enclosure characteristics' (Table 5.4). Furthermore, 'Physical barriers' was negatively correlated with the proportion of penguins visible and huddling and positively correlated with penguins being close to the visitor viewing area and surface swimming (Table 5.4). When visitors were asked to rate (out of 10) the welfare of the little penguins and their enclosure, both were positively correlated with the proportion of penguins close to the visitor viewing area, surface swimming and diving and negatively correlated with the proportion of penguins idle (Table 5.4).

Table 5.4. Pearson correlations between scale mean scores and little penguin behaviours. The angular transformation was used for penguin behaviours.

	Penguins visible	Huddling	<1m from side A of the visitor viewing area	>1m from side A of the visitor viewing area	<1m from side B of the visitor viewing area	>1m from side B of the visitor viewing area	Resting	Idle	Locomotion	Vigilant	Surface Swimming	Diving
Scale mean scores (Likert scale 1-5: 1=strongly disagree, 5=strongly agree)												
Positive penguin characteristics	0.35	-0.21	0.52**	-0.13	0.56**	-0.23	-0.20	-0.43*	-0.28	0.15	0.66**	0.66**
Perceived Aggressiveness	0.11	-0.16	0.08	0.13	0.05	0.11	-0.18	0.02	0.25	0.21	0.13	-0.07
Perceived Timidness	-0.15	0.03	-0.21	-0.22	-0.15	-0.22	-0.59**	0.25	0.26	-0.12	-0.30	-0.19
Negative penguin welfare	-0.48*	0.10	-0.33	0.09	-0.41*	0.22	0.12	0.38	0.45*	-0.20	-0.51*	-0.59*
Positive penguin welfare	0.44*	-0.06	0.30	-0.10	0.37	-0.19	-0.32	-0.42*	-0.34	0.27	0.55**	0.59**
Positive visitor effect	0.19	-0.22	0.27	-0.08	0.35	-0.19	-0.30	-0.31	-0.03	0.05	0.46*	0.47*
Neutral visitor effect	0.54**	0.06	0.20	0.04	0.33	-0.11	-0.20	-0.26	-0.37	0.27	0.41*	0.42*

Positive enclosure characteristics	0.42*	-0.11	0.15	-0.13	0.32	-0.28	-0.22	-0.37	-0.48*	0.18	0.42*	0.44*
Negative enclosure characteristics	-0.13	0.23	-0.28	0.29	-0.41*	0.41*	0.30	0.37	0.32	0.01	-0.45*	-0.44*
Learning	-0.15	-0.28	0.25	-0.42*	0.32	-0.50*	-0.17	-0.29	-0.32	-0.37	0.29	0.39
Experience	0.30	-0.24	0.35	-0.14	0.43*	-0.26	-0.11	-0.47*	-0.32	0.06	0.58**	0.65**
Interests	-0.25	0.16	-0.27	-0.03	-0.18	-0.06	-0.02	0.23	-0.04	-0.33	-0.24	-0.27
Visual barriers	-0.50*	-0.30	0.17	-0.24	0.04	-0.15	0.11	-0.03	0.39	-0.15	-0.02	-0.27
Physical barriers	-0.42*	-0.62**	0.49*	-0.48*	0.44*	-0.48*	-0.45*	-0.23	0.31	-0.29	0.46*	0.31
Rating questions (scale 1-10, 1=very poor, 10=excellent)												
Welfare of little penguins	0.08	-0.39	0.42*	-0.34	0.50*	-0.46*	-0.12	-0.58**	-0.33	-0.12	0.61**	0.64**
Little penguin enclosure	0.05	-0.28	0.35	-0.42*	0.48*	-0.55*	-0.22	-0.47*	-0.46*	-0.07	0.48*	0.38
Visitor experience at the little penguin enclosure	0.40	-0.02	0.15	-0.04	0.23	-0.14	0.01	-0.35	-0.42*	0.151	0.36	0.48*

*Correlation is significant at the 0.05 level (2-tailed).

**Correlation is significant at the 0.01 level (2-tailed).

5.4.4 Treatment effects on visitor attitudes and rating questions

Analysis of variance revealed few differences in visitor attitudes (3 out of 17) between the treatment groups (Table 5.5). The treatment groups were standard zoo conditions (Control), a physical barrier in place to regulate visitor viewing proximity but no signs (Physical barrier), signs present to attempt to regulate the intensity of visitor behaviours but no physical barrier (Signs) and both a physical barrier in place and signs present to regulate both visitor viewing proximity and behavior (Physical barrier and Signs; Table 5.1 and 5.5). It was found that the treatment groups only significantly differed ($p < 0.05$) in their attitudes towards 'Positive penguin characteristics' ($F_{3,469} = 3.18$, $p = 0.024$), 'Neutral visitor effects' ($F_{3,468} = 4.89$, $p = 0.0023$) and 'Physical barriers' ($F_{3,474} = 3.64$, $p = 0.013$; Table 5.5).

A 'Least Significant Difference' post hoc test was performed and found that attitudes towards 'Positive penguin characteristics' differed between visitors in the 'Physical barrier' and 'Signs' treatment groups: visitors exposed to the physical barrier had more positive attitudes compared to visitors only exposed to signs. In other words, visitors exposed to the physical barrier agreed more that the little penguins were playful, curious, intelligent, interactive, proactive, friendly, and social compared to visitors exposed to signs (Table 5.5).

For attitudes towards 'Neutral visitor effects', differences were found between visitors in the 'Control' group and 'Signs' treatment group and between visitors in the 'Control' and 'Physical barrier and Signs' treatment group (Table 5.5). Visitors in the 'Control' agreed more that penguins do not find visitors fear-provoking and are unbothered by visitors compared to visitors that were only exposed to signs or both to a physical barrier and signs (Table 5.5). Also, differences were found between visitors in the 'Physical barrier' and 'Signs' treatment groups where visitors only exposed to a physical barrier agreed more that penguins do not find visitors fear-provoking and are unbothered by visitors compared to visitors exposed only to signs, who on average neither agreed nor disagreed visitors affect penguins (Table 5.5).

Attitudes towards 'Physical barriers' differed between visitors in the 'Control' and visitors in all other treatment groups (Table 5.5). Visitors in the 'Control' had fairly neutral attitudes (i.e., neither agreed nor disagreed) towards physical barriers but visitors exposed to the physical barrier, signage, or a combination of both, agreed more that physical barriers improve visitor experience and penguin welfare (Table 5.5). Therefore, visitors in the treatment groups had more positive attitudes towards 'Physical barriers' compared to visitors exposed to standard zoo conditions (Table 5.5).

No significant treatment effects were found on any other attitude scales or the questions where visitors rated the welfare of the penguins, the penguin enclosure, and their own experience at the exhibit ($p>0.05$).

Table 5.5. The effect of the treatments on scale mean scores ($\pm$ SEM) and rating questions.

	Control (standard zoo conditions)	Physical barrier	Signs	Physical barrier & Signs	P-value
Scale mean scores (Likert scale 1-5: 1=strongly disagree, 5=strongly agree)					
Positive penguin characteristics	3.71 $\pm$ 0.05	3.81 $\pm$ 0.05	3.57 $\pm$ 0.07	3.67 $\pm$ 0.06	0.024
Perceived Aggressiveness	1.71 $\pm$ 0.08	1.74 $\pm$ 0.07	1.95 $\pm$ 0.11	1.92 $\pm$ 0.08	0.072
Perceived Timidness	3.56 $\pm$ 0.09	3.60 $\pm$ 0.07	3.57 $\pm$ 0.11	3.37 $\pm$ 0.08	0.17
Negative penguin welfare	2.56 $\pm$ 0.06	2.67 $\pm$ 0.05	2.76 $\pm$ 0.06	2.66 $\pm$ 0.05	0.17
Positive penguin welfare	3.76 $\pm$ 0.06	3.74 $\pm$ 0.04	3.64 $\pm$ 0.06	3.64 $\pm$ 0.05	0.24
Positive visitor effect	2.81 $\pm$ 0.06	2.82 $\pm$ 0.06	2.78 $\pm$ 0.07	2.83 $\pm$ 0.06	0.96
Neutral visitor effect	3.37 $\pm$ 0.07	3.28 $\pm$ 0.06	2.99 $\pm$ 0.08	3.15 $\pm$ 0.07	0.0023
Positive enclosure characteristics	3.42 $\pm$ 0.08	3.39 $\pm$ 0.06	3.31 $\pm$ 0.08	3.42 $\pm$ 0.06	0.69
Negative enclosure characteristics	2.88 $\pm$ 0.08	2.95 $\pm$ 0.07	3.04 $\pm$ 0.09	2.85 $\pm$ 0.07	0.44
Learning	2.71 $\pm$ 0.09	2.87 $\pm$ 0.07	2.76 $\pm$ 0.09	2.76 $\pm$ 0.09	0.49
Experience	3.98 $\pm$ 0.07	3.93 $\pm$ 0.05	3.95 $\pm$ 0.06	3.97 $\pm$ 0.05	0.88
Interests	3.78 $\pm$ 0.06	3.77 $\pm$ 0.05	3.77 $\pm$ 0.07	3.76 $\pm$ 0.06	0.99
Visual barriers	3.50 $\pm$ 0.08	3.74 $\pm$ 0.06	3.76 $\pm$ 0.08	3.70 $\pm$ 0.07	0.061
Physical barriers	3.26 $\pm$ 0.07	3.52 $\pm$ 0.06	3.55 $\pm$ 0.09	3.54 $\pm$ 0.07	0.013
Rating Questions (scale 1-10, 1=very poor, 10=excellent)					
Welfare of little penguins	7.52 $\pm$ 0.17	7.57 $\pm$ 0.14	7.46 $\pm$ 0.20	7.81 $\pm$ 0.15	0.47
Little penguin enclosure	7.04 $\pm$ 0.21	6.78 $\pm$ 0.18	6.57 $\pm$ 0.25	7.21 $\pm$ 0.19	0.16
Visitor experience at the little penguin enclosure	6.65 $\pm$ 0.21	6.42 $\pm$ 0.18	6.33 $\pm$ 0.25	6.38 $\pm$ 0.21	0.74

5.5 Discussion

Several visitor attitude scales were found to be correlated with penguin behaviour, but it should be noted that due to the large number of statistical tests, only those attitude variables that were consistently correlated with more than one penguin behaviour variable are discussed. In contrast, there were only a few treatment effects on these scales. The correlations indicate that the more visible, active, and close the penguins were to the visitor viewing area, the more positive visitor attitudes were towards positive little penguin characteristics, penguin welfare, visitor effects, the enclosure, learning, visitor experience and exhibit manipulations. This suggests penguins that display fewer behaviours indicative of fear such as avoidance, huddling and vigilance and more behaviours that are active such as swimming and diving, elicit more positive visitor attitudes towards the penguins, their welfare, enclosure, and visitor experience. Our findings are supported by studies that have found zoo animals that engage in active behaviours and increased behavioural diversity, improve visitor perceptions of the animals (Anderson et al., 2003), predict visitors' self-reported positive affective responses (Luebke et al., 2016) and increase conservation intent (Hacker and Miller, 2016). In contrast, other studies have found zoo animals that display stereotypic behaviours such as pacing, reduced visitor perceptions of the animals' welfare and the level of care for the animals and decreased support for zoos (Miller, 2012; Godinez et al., 2013). Thus, the current results, consistent with previous research, provides evidence that zoo animal behaviour is an important factor that is associated with zoo visitor attitudes and experience.

It is well understood that human attitudes can be a strong predictor of human behaviour as demonstrated by the agricultural research on human-animal relationships (Fishbein and Ajzen, 2010; Hemsworth and Coleman, 2011). Positive attitudes in stockpeople towards animals they work with, have been found to result in increased positive handling towards animals and subsequently, positive effects on animal behaviour and welfare which reinforces positive handling and attitudes (Hemsworth and Coleman, 2011). Chiew et al. (2019) found similar results to that of Sherwen et al. (2015b) where the close proximity of visitors which increased intense visitor behaviours such as leaning over the enclosure, sudden movement and tactile contact with the enclosure and pool's water, increased little penguin avoidance behaviour and other behaviours indicative of fear but not faecal glucocorticoid metabolite concentrations (Chiew et al., 2019). This suggests that despite the positive visitor attitudes towards little penguins at Melbourne Zoo, visitors still had a negative effect on the penguins which contrasts with the agricultural research on human-animal relationships (Hemsworth and Coleman, 2011). This may be because

positive visitor attitudes towards penguins may have increased visitors' desire to interact or be in close contact with penguins, thus engaging in potentially intense and threatening visitor behaviours and resulting in negative effects on the penguins. However, we were not able to directly correlate each visitor's attitudes with their behaviour and in the present study we examined the general attitudes of visitors towards little penguins rather than the visitors' attitudes specifically towards the behaviours that they, as visitors, engage in towards little penguins. Consequently, further research is clearly required to understand visitor attitudes towards the behaviours they engage in when viewing zoo animals.

It is also possible that visitors may lack knowledge or awareness of the effect they can have on zoo animals. This is supported by the finding where attitudes towards 'Positive visitor effects' and 'Neutral visitor effects' were on average neutral (i.e., neither agreed nor disagreed). These results suggest the uncertainty visitors have about whether little penguins find visitors positive, negative, or neutral. If visitors are not aware that their behaviour may result in negative consequences on penguins, provision of such information may allow visitors to choose to change their behaviour that may minimize their negative effect on penguins. Abraham and Denford (2017) argue that the provision of information may be vital in changing people's behaviour when people lack an understanding of their own behaviour or its consequences. Thus, visitor education to raise awareness of visitor effects may be required to shift and modify visitor behaviour to minimize negative effects on zoo animals. Research in agriculture has demonstrated that stockperson attitudes and their behaviour towards animals can be improved through training (Hemsworth et al., 1994; Coleman et al., 2000). Consequently, further research is required to examine visitor attitudes and behaviour in conjunction with the examination of visitor effects, identifying what behaviours visitors are performing that may affect zoo animals and attitudes towards those behaviours so that they can be targeted and modified.

Despite the growing research investigating how zoo animal behavior influences visitors' attitudes, there is still limited research to link this understanding with observations of visitor effects on zoo animals. This is important as it may help with identifying strategies to manage zoo visitor-animal interactions. For example, Blaney and Wells (2004) found that visual contact with visitors resulted in increased intra-group aggression and abnormal behaviors including repetitive teeth clenching and body rocking in gorillas (Blaney and Wells, 2004). However, installation of camouflage netting to the viewing area of the gorilla exhibit to reduce the visibility of visitors, reduced conspecific-directed aggression and stereotypic behaviors in the gorillas but also increased visitor perceptions of gorillas where they were perceived as more exciting and less aggressive (Blaney and Wells, 2004). This demonstrates that the camouflage netting is a highly suitable management strategy to manage zoo

visitor-gorilla interactions that has no detrimental impact, and rather positive effect, on the animals and visitors. In contrast, some research has found that modification of zoo visitor-animal interactions using visual or physical barriers, for example, may affect visitor experience and potentially visitor attitudes despite the improvement in animal welfare (Sherwen et al., 2015a;Chiew et al., 2019). This highlights the importance of examining visitor attitudes when investigating the effects of visitors on zoo animals to identify suitable ways to manage visitor-animal interactions. Consequently, the second aim of our present experiment was to address this by determining the effects of regulating visitor-penguin interactions by imposing exhibit manipulations (i.e., treatments: physical barrier and/or signage) to the visitor viewing area on visitor attitudes.

No treatment effects were found on visitor attitudes towards penguin welfare, the exhibit, learning, visitor experience, visitor interests and visual barriers as well as how visitors rated the penguins' welfare, the enclosure, and their own experience at the enclosure. This suggests that there was no detrimental impact of a physical barrier and/or signage on these visitor attitude scales or visitor experience. Interestingly, this contrasts with the few studies that have suggested one-way visual barriers to reduce visual contact with visitors and a physical barrier to regulate visitor viewing proximity and behavior, may negatively affect visitors and their experience due to the reduced visitor numbers and reduced interaction with zoo animals at the exhibit when these barriers are in place (Sherwen et al., 2015a;Chiew et al., 2019). However, there were some differences in visitor attitudes between visitors that were exposed to standard zoo conditions, a physical barrier (set up 2 m from the enclosure), signage or a combination of both a physical barrier and signs for attitudes towards 'Positive penguin characteristics', 'Neutral visitor effects' and 'Physical barriers'.

Visitors exposed to standard zoo conditions had more positive attitudes that penguins are not affected by visitors compared to visitors exposed to the exhibit manipulations which on average were neutral (i.e., neither agreed nor disagreed). Considering there is evidence indicating penguins can be negatively affected by visitors (Ozella et al., 2014;Sherwen et al., 2015b;Chiew et al., 2019), this result may be a concern for zoos as it suggests that visitors exposed to standard zoo conditions have misconceptions that visitors do not affect penguins. In comparison, visitors exposed to exhibit manipulations may have considered more the potential effects visitors have on penguins because of the presence of the exhibit manipulations. Thus, this suggests that exhibit manipulations may be a positive influence on visitor attitudes towards visitor effects. However, attitudes towards 'Positive little penguin characteristics' differed between visitors that were exposed only to either a physical barrier or signage, indicating visitors exposed to a physical barrier had more positive attitudes towards 'Positive little penguin characteristics' compared to visitors

exposed to signs. This was also found for attitudes towards 'Neutral visitor effects' indicating visitors exposed to a physical barrier had slightly more positive attitudes compared to visitors exposed to signs. This suggests that the type of exhibit manipulation or strategy to manage visitor-animal interaction is important where signs may have more of a negative influence on visitor attitudes compared to a physical barrier. This is somewhat consistent with Blaney and Wells (2004) which as previously discussed found camouflage netting (i.e., a physical barrier) installed to the viewing area of the gorilla exhibit, increased positive perceptions of gorillas. However, Meis and Kashima (2017) found that what influences the perceived effectiveness of a sign is the clarity of the signs purpose, especially for unfamiliar signs which in our study were unfamiliar and may not have had a clear purpose for visitors. This could explain why there was a potential negative effect on attitudes when visitors were exposed to signs in the present study compared to visitors that were not, since limited explanation was given to visitors as to why they were requested to be quiet, move slowly and not interact with the animals. However, clearly further research is still required to understand the effectiveness of signs within zoos on visitor attitudes and behaviour.

Based on the few treatment effects on visitor attitudes, the results suggest that, if a management strategy were to be implemented to manage visitor-penguin interactions, a physical barrier may be more suitable over the use of signage, having less of a negative influence on visitor attitudes compared to signs. This is also supported by our finding that irrespective of whether it was the visitors exposed to a physical barrier, signage, or a combination of both, in comparison to the visitors exposed to standard zoo condition, visitor attitudes towards physical barriers were more positive. In other words, there was more agreement that physical barriers would improve both visitor experience and penguin welfare when visitors were exposed to the exhibit manipulations compared to those that were not. Furthermore, Chiew et al. (2019) found that the physical barrier reduced potentially threatening visitor behaviors such as banging on enclosure features, leaning over the pool, tactile contact with the pool's water and sudden movement while signs had no effect on visitor behavior. This is also supported by Park et al. (2008) that found direct management by using a physical fence, was the most effective strategy to control visitor behavior compared to educational signage at Acadia National Park, USA. Consequently, our findings suggest that a physical barrier could be a suitable management strategy to manage visitor-penguin interactions. However, it should be noted that it is unclear if these few treatment effects on visitor attitudes affected visitor attitudes directly or was a consequence of the treatment effects on penguin behavior that influenced visitor attitudes. For example, it was likely that the increased positive perceptions of the gorillas by visitors found by Blaney and Wells (2004) was influenced by the presence of the camouflage netting but also the changes

in gorilla behavior because of the camouflage netting reducing visual contact with visitors.

We recognize that the methodology used in the present study, does not allow us to disentangle the direct effects on visitor attitudes of regulating visitor viewing proximity and behavior using a physical barrier and/or signage per se, from the effects of changes in penguin behavior on attitudes arising from this regulation. Also, the generalizability of our findings to other zoos is limited and the questionnaires completed were biased towards people living in Australia, pet owners and females which are common biases found in survey data (Driscoll, 1992; Kendall et al., 2006). Therefore, the visitors surveyed within our present study may not be representative of the population of visitors to Melbourne Zoo. Furthermore, we recognize that using the average daily penguin behavior and survey data, may have diluted the effects and masked the variation that is possible throughout the day in both penguin behavior and visitor attitudes. However, using daily averages and a randomized factorial design with three replicates of each treatment helps average out chance variation. Despite these limitations, the results gathered in our experiment provides insight on current visitor attitudes at Melbourne Zoo and has identified some influencing factors on visitor attitudes which provides a foundation for further research to build upon.

5.6 Conclusions

This study is the first study, to our knowledge, that provides information on visitor attitudes specifically towards zoo-housed little penguins, their welfare, enclosure, visitor effects, visitor experience and exhibit manipulations at an Australian zoo. We were able to identify two factors that influence visitor attitudes which were little penguin behaviour and exhibit manipulations. The more visible, active, and close the penguins were to the visitor viewing area, the more positive visitor attitudes were towards positive little penguin characteristics, penguin welfare, visitor effects, the enclosure, learning, visitor experience and exhibit manipulations. However, there were limited effects of the exhibit manipulations on visitor attitudes and experience. These findings have increased our understanding of the multifaceted nature of visitor attitudes and have identified some influencing factors on attitudes that can be used to inform the way zoos manage visitor-penguin interactions, but clearly further research is required.

Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Author Contributions: SC, PH, SS, VM and GC designed the study. SC was responsible for liaising with the Wild Seas keeping team and other staff at Melbourne Zoo (Zoos Victoria, Australia) as well as the staff and student volunteers and interns from the Animal Welfare Science Centre (University of Melbourne, Australia). SC organised and carried out the data collection with the help of student volunteers and interns from the Animal Welfare Science Centre. SC collated all data and with the aid of GC, performed the statistical analysis of the data and interpretation. SC and GC wrote the paper. PH, SS and VM provided feedback and additions to the paper.

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Chapter 6

Visitor attitudes towards little penguins (*Eudyptula minor*) at two Australian zoos.

This chapter compared zoo visitor attitudes towards zoo-housed little penguins, their enclosure and visitor experience at Melbourne Zoo and Taronga Zoo.



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6.1 Abstract

This study identified and compared the attitudes of visitors toward zoo-housed little penguins, their enclosure and visitor experience that may influence the way visitors behave toward little penguins at two Australian zoos. Visitor attitudes were assessed using an anonymous questionnaire, targeting visitor beliefs, and experiences, where visitors were randomly approached at the penguin exhibit after they had finished viewing the penguins. Visitors were given two options to complete the questionnaire, on an iPad during their zoo visit or online (URL sent via email) after their zoo visit. A total of 638 participants (495 at Melbourne Zoo and 143 at Taronga Zoo) completed the questionnaire, 42% were completed onsite during their zoo visit and 58% were completed online after their zoo visit. Most participants were living in Australia, non-zoo members, female, previously or currently owned a pet, aged between 26 and 35 years and had a University degree. Results showed that the attitude dimensions of visitors were consistent between the two zoos which indicates that these measures of attitudes were stable over time and location. Overall, visitors at both zoos had positive attitudes toward little penguins, penguin welfare, the enclosure, and visitor experience. However, whether these positive attitudes and positive visitor experience influenced the way visitors behaved toward the penguins remains unclear. There were some differences in visitor attitudes toward the perceived “aggressiveness” and “timidness” of little penguins, “negative penguin welfare,” “experience with the penguins”, “learning”, “visual barriers” and the way visitors rated their overall experience at the penguin enclosure. While the reasons for the differences in visitor attitudes and visitor experience between the zoos were not clear, some factors such as penguin behaviour and enclosure design, may have been attributable to these differences. Also, a relationship was found between visitor attitudes and how visitors rated the welfare of penguins, the enclosure and visitor experience at the enclosure; more positive visitor attitudes were associated with higher ratings of penguin welfare, the enclosure and visitor experience. The practical implications of these results for zoos are unclear because the differences in visitor attitudes were numerically small. This requires further comparisons between zoos or enclosures that are more markedly different than the penguin enclosures in the present study and further research on how visitors assess zoo animals, enclosures, and visitor experience.

Keywords: comparisons between zoos, little penguins, visitor attitudes, visitor experience, visitor-animal interactions, zoos, zoo visitors.

6.2 Introduction

Visitors are important targets of many zoo conservation, education and advocacy campaigns that are designed to mitigate human-driven threats to wildlife by influencing visitor attitudes and behaviour (Reade and Waran, 1996; Davey, 2007; Skibins and Powell, 2013; Godinez and Fernandez, 2019; Howell et al., 2019). This is important because conservation and education forms the ethical foundation and justification of zoos for keeping wildlife in captivity (Maple, 2008; Ward and Sherwen, 2018; Godinez and Fernandez, 2019; Sherwen and Hemsworth, 2019). But a number of factors appear to influence visitor attitudes towards zoos and their animals, conservation-related attitudes, and the behaviour of zoo visitors. For example, some of these factors include enclosure design, visitor interactions with animals, animal behaviour as well as the frequency of zoo visits (Woods, 2002; Yalowitz, 2004; Lukas and Ross, 2005; Miller et al., 2013; Clayton et al., 2017; Luebke, 2018; Chiew et al., 2019b; Godinez and Fernandez, 2019). Nevertheless, knowledge of visitor attitudes is important because attitudes are drivers of behaviour (Ajzen, 1991). By understanding visitor attitudes, zoos can gain a better understanding of their visitors and their behaviour which can be targeted to promote visitor support for zoos, proconservation behaviours and raise visitor awareness of wildlife conservation (Lukas and Ross, 2005; Martín-López et al., 2007; Pearson et al., 2013; Pearson et al., 2014a; Pearson et al., 2014b; Mellish et al., 2019). It is important that we define what “attitudes” are because they are often interchangeably used with “perceptions”. Attitudes are a complex combination of human factors including personality, beliefs, values, behaviours, and motivations (Ajzen, 1985; Pickens, 2005). However, they can be defined by three interconnected components: a person’s beliefs about the object (cognition), their emotional response to the object (affect) and their behavioural tendency towards the object (conation) (Ajzen, 1985; Pickens, 2005; Hemsworth and Coleman, 2011; Albarracin et al., 2014). Therefore, attitudes are the mindset or tendency for a person to act in a certain way and reflect a positive or negative assessment of a given object, which are derived from beliefs and are a strong determinant of behaviour (Ajzen, 1985; Eagly and Chaiken, 1993; Pickens, 2005). Perceptions, in comparison, are an individual’s interpretation of given situations, stimuli or objects into something meaningful based on past experiences (Ajzen, 1985; Pickens, 2005).

Much of the research to date examining zoo visitor attitudes has primarily been focused on evaluating the impact of zoo-based conservation education and the zoo experience on visitors’ knowledge of and attitudes towards zoo animals (Falk et al., 2007; Marino et al.,

2010; Miller et al., 2013; Pearson et al., 2013; Pearson et al., 2014a; Pearson et al., 2014b; Roe et al., 2014; Godinez and Fernandez, 2019; Mellish et al., 2019; Kleespies et al., 2020). These aspects of visitors, knowledge and attitudes, may be related to a visitor's behavioural intention to engage in proconservation-related behaviours (Lukas and Ross, 2005; Martín-López et al., 2007; Godinez and Fernandez, 2019). For example, while not a linear relationship, zoo visitors who were found to have greater knowledge about orangutans (*Pongo abelii*) and dolphins, had more positive attitudes towards these animals which in turn, were found to be associated with increased behavioural intentions of engaging in future conservation behaviour for these species (Miller et al., 2013; Pearson et al., 2013; Pearson et al., 2014a). In comparison, more potentially harmful behaviours toward marine wildlife and less engagement in proconservation behaviours were found when public attitudes towards marine wildlife were negative and knowledge of marine wildlife and their related conservation issues were poor (Barney et al., 2005; Pearson et al., 2014b). This relationship between knowledge, attitudes and behaviour is based on the Theory of Planned Behaviour which proposes that human behaviour may be predicted by attitudes towards their behaviour, subjective norms, and the perceived behavioural control of their behaviour (Ajzen, 1991; Fishbein and Ajzen, 2010). Consequently, evaluation of the zoo experience on zoo visitors is important because it helps identify the effectiveness of zoos in promoting behavioural change in their visitors for the purpose of wildlife conservation and education (Whitham and Wielebnowski, 2013; Roe et al., 2014; Sherwen et al., 2018; Godinez and Fernandez, 2019). However, little is known about whether the attitudes of visitors towards zoo animals and visitor experience influences the way visitors behave towards zoo animals.

In situations where there is close proximity between stockpeople and their livestock, attitudes towards livestock can influence the way stockpeople behave towards animals they work with (Hemsworth and Coleman, 2011). The relevant stockperson behaviour includes not only tactile contact, but also other aversive behaviours including speed of movement and noise production. Positive attitudes in stockpeople towards livestock and working with livestock has been shown to decrease aversive behaviours and result in positive outcomes on animal behaviour and welfare (Hemsworth and Coleman, 2011; Munoz et al., 2019). Whether similar relationships between zoo visitor attitudes and behaviours that may be aversive to zoo animals remains poorly understood. There has been a substantial increase in evidence that zoo visitors can affect a wide range of zoo species (Fernandez et al., 2009; Ward and Sherwen, 2018; Sherwen and Hemsworth, 2019). Most research to date has found that zoo visitors can negatively affect many zoo species, shown by increases in animal behaviours such as aggression, avoidance and

stereotypies or increases in physiological measures such as faecal glucocorticoid metabolite concentrations (Sherwen and Hemsworth, 2019). Despite these findings, there is limited understanding of what visitor behaviours result in these negative effects on zoo animals. There is evidence to suggest that it may be certain visitor behaviours that are generally fear-provoking, particularly those that are intense, loud, fast, and sudden, that negatively affect zoo animals (Hemsworth et al., 2018; Sherwen and Hemsworth, 2019). Therefore, potentially fear-provoking visitor behaviours such as looming over animals, loud vocalisations or sudden movements may be influenced by visitor attitudes towards zoo animals and the experience of visitors while at the zoo or specific animal exhibit. For example, visitor perceptions of the gorillas (*Gorilla gorilla gorilla*) were perceived as more exciting and less aggressive when camouflage netting was installed at the viewing area of the exhibit (Blaney and Wells, 2004). At the same time, the camouflage netting reduced conspecific-directed aggression and stereotypic behaviour in gorillas (Blaney and Wells, 2004). It is apparent that visitor perceptions of the gorillas were influenced by the camouflage netting and the change in gorilla behaviour. But there was some suggestion that visitors became quieter and engaged in less intense behaviours (e.g., banging on the glass windows) towards the gorillas when the netting was installed (Blaney and Wells, 2004). The change in visitor behaviour may have also been influenced by their improved perceptions of the gorillas although association specifically between visitor perceptions of gorillas and visitor behaviour was not examined. Furthermore, visitor experiences at zoos such as presentations, informative signage, immersive naturalistic exhibits and interactions with zoo animals and staff, have been found to influence visitor attitudes towards zoo animals and visitors' emotional connections with and appreciation for zoo animals and learning (Reade and Waran, 1996; Miller et al., 2013; Mann et al., 2018; Godinez and Fernandez, 2019). Consequently, understanding visitor attitudes towards zoo animals and their connection with visitor experience can provide valuable insight into the attitudes that may drive the way visitors behave towards zoo animals. These attitudes can then be targeted by zoos to promote behavioural change in visitors to help zoos better manage visitor-animal interactions.

Penguins are commonly housed in zoos and have been referred to as a charismatic species based on their aesthetic appeal, being perceived as “cute” and have the ability to invoke a large amount of emotional affinity (Woods, 2000; Stokes, 2007; Tucker, 2007; Seddon and Ellenberg, 2008; Colléony et al., 2017; Chiew et al., 2020). Yet, there has been limited research to understand the attitudes of visitors towards this group of aquatic birds and lack of bird species being studied in general (Hosey et al., 2020). Additionally, there has been a lack of research comparing visitor attitudes and visitor experience between zoos.

Some studies that have investigated the affective responses of visitors to observing animal behaviour have involved a range of zoos in order to capture a wide range of visitors and account for the variation in visitor responses between zoos (Myers et al., 2004; Luebke et al., 2016; Godinez and Fernandez, 2019). However, research to date has yet to focus on understanding the differences and/or similarities in visitor attitudes towards a specific zoo species and visitor experience between zoos. Visitor attitudes towards the same zoo species at different zoos may be the same while visitor experience could differ between zoos because of factors such as features within zoos that promote positive experiences. By comparing visitor attitudes towards specific zoo species and visitor experience between zoos, this can help identify factors that may influence visitor attitudes and experiences that generalise across zoos.

The present study targeted visitors' beliefs about the little penguins, their enclosure and visitor experience. This is because beliefs, as one of the three components of attitudes, permits an individual's underlying attitudes to be inferred (Eagly and Chaiken, 1993; Pickens, 2005; Hemsworth and Coleman, 2011; Albarracin et al., 2014). Consequently, the term "attitude" as used in this study refers to visitor beliefs. The aim of the present study was to identify and compare the attitudes of visitors towards zoo-housed little penguins, their enclosure and visitor experience that may influence the way visitors behave towards little penguins at two Australian zoos.

6.3 Methodology

6.3.1 Visitor questionnaires

This study obtained human ethics approval from the Veterinary and Agricultural Sciences Human Ethics Advisory Group, Faculty of Veterinary and Agricultural Sciences, University of Melbourne, Australia (Ethics Application 1545739.1 and 1545739.3). Questionnaires were developed and refined based on focus groups discussions with visitors at Melbourne Zoo (Melbourne, Australia) and Taronga Zoo (Sydney, Australia) (Chiew et al., 2019b). A slightly modified version of the questionnaire used in Chiew et al. (2019b) was used at Taronga Zoo and implemented a similar methodology. Only question items that were consistent across the two zoos were included in this present study.

Visitors at both zoos were randomly approached at the penguin exhibit after they had finished viewing the penguins and had exited the exhibit area by a member of the research team (student volunteers, interns or a research assistant from the Animal Welfare Science Centre, University of Melbourne). At Melbourne zoo, visitors were

approached during seven 30 min time blocks between 09:30 and 15:15 h (Chiew et al., 2019b). At Taronga zoo visitors were approached between 11:00-12:00 h and 14:00-15:00 h. For Melbourne Zoo, the time blocks were selected based on visitors being found to visit the penguin enclosure throughout the day. At Taronga Zoo, the selected times blocks were identified to be the peak times visitors were located at the penguin exhibit area. To increase participation, visitors were provided two options to complete the questionnaire, either on an iPad (on site during their zoo visit) or online (URL sent via email, after their zoo visit).

The questionnaire took no longer than 10 minutes and was divided into five sections: Section 1 collected information on the participants' demographic information; Section 2 collected information on the participants' attitudes towards the little penguins; Section 3 collected information on the participants' attitudes towards the little penguin enclosure, Section 4 collected information on the participants' experience; and the final section assessed the participants' attitudes towards manipulations to the penguin enclosure.

Questionnaires were conducted on all study days during zoo opening hours. Attitude questions within the questionnaire used a 5-point Likert scale with the following options: 1. Strongly disagree, 2. Disagree, 3. Neither agree nor disagree, 4. Agree and 5. Strongly agree. Responses were scored so that disagreement with a statement had lower scores and agreement had higher scores. For rating questions in which visitors were asked to rate the welfare of the little penguins, the little penguin enclosure and visitor experience at the penguin enclosure, a rating scale out of 10 was utilised where 1 was very poor and 10 was excellent.

Visitor attitudes were surveyed in conjunction with our studies that investigated the effects of regulating visitor contact on little penguin behaviour at Melbourne and Taronga Zoo, using exhibit manipulations: a physical barrier and visual barrier, respectively (Chiew et al., 2019a;Chiew et al., 2020). Consequently, the number of days questionnaires were collected differed between the zoos as a result of the differing experimental designs i.e., 24 study days at Melbourne Zoo and 10 study days at Taronga Zoo.

6.3.2 Data analysis

Statistical analyses using SPSS version 25 included frequency distributions of demographic factors across response categories in the questionnaire and principal component analyses (PCAs) on attitudinal data at each zoo. Before PCAs were performed, any questions that were not consistent across the two zoos were removed to ensure only questions that were the same at the two zoos were included for analysis.

Attitudinal data from the questionnaire were subjected to PCAs for each zoo separately, to reduce the large number of attitude variables to a relatively small number of components, where the components reflected commonalties amongst those individual variables that correlated highly with each other. The Kaiser-Meyer-Olkin Measure of Sampling Adequacy and Bartlett's test of sphericity values were used to assess the suitability of the data set to be subjected to PCA (Pallant, 2007). The criterion for the Kaiser-Meyer-Olkin Measure of Sampling Adequacy is 0.60 or above and Bartlett's test of sphericity had to be significant ($p < 0.05$) which indicated the data set was suitable for PCA (Pallant, 2007). Also, using Kaiser's criterion, only components with eigenvalues exceeding 1 were retained (Pallant, 2007). Cronbach's α coefficients were used as a measure of scale reliabilities, with an $\alpha \geq 0.70$ as the criterion for acceptable reliability (Pallant, 2007). Scale reliability is the degree to which the question items, that make up the component, are assessing the same underlying construct (Briggs and Cheek, 1986; Pallant, 2007). When Cronbach's α coefficients were found to be below the criterion, inter-item correlations were used as a secondary measure of scale reliability as low Cronbach's α can be the result of a scale containing fewer than 10 items. Consequently, inter-item correlations were used when this situation was encountered and the criterion for acceptable reliability is within the range of 0.20-0.50 (Briggs and Cheek, 1986).

Items were included in a component if their loading on the relevant component exceeded 0.33 and if, based on face validity and semantic content, they could be summarised by a single construct (Pallant, 2007; Tabachnick and Fidell, 2007). Varimax or oblimin rotations were performed on component solutions of more than one factor to simplify interpretation (Pallant, 2007). The decision about which rotation was used was based on the component correlation matrix. If correlations were greater than 0.30 within this matrix, indicating that there was more than 10% overlap in variance between the components and so were considered correlated, an oblimin rotation was used (Pallant, 2007; Brown, 2009). If correlations were below 0.30, then a varimax rotation was used. Loadings above 0.70 were considered strong/excellent (Tabachnick and Fidell, 2007). Subjective labelling of each component, produced from the PCAs, based on semantic content of the items was performed. Scale mean scores for each component were then calculated so that the averages were on the same scale as the original question items i.e., 5-point Likert scale. Individual questions related to little penguin aggressiveness, timidness, and cuteness (i.e., do you think little penguins are aggressive/timid/cute?) were analysed separately because these question items did not reliably measure a common underlying construct when subjected to PCA. Also, the three rating questions where visitors were asked to rate the welfare of the little penguins, the enclosure and

visitor experience at the enclosure were analysed separately because a different rating scale (i.e., out of 10) to the attitudinal statements was used. Therefore, a total of six individual question items were analysed separately as single items in addition to the scale mean scores of the PCA components.

From each zoo, the scale mean scores for each component and the individual question items were used as measures of visitor attitudes for subsequent statistical analyses. Chi square tests were conducted to identify differences in visitor demographics between the two zoos. Multivariate analysis of variance (MANOVA) on the scale mean scores for each component and the individual question items were conducted to make comparisons of visitor attitudes between the two zoos, demographics and the interaction between zoo property and demographics. Prior to these MANOVAs, Levene's test statistic was used to test for homogeneity of variance. When differences in visitor attitudes (i.e., dependent variables) between the zoos and/or demographics (i.e., independent variables) were identified from MANOVAs, univariate analyses were then examined to identify which attitudes differed between the two zoos and/or demographics. Partial correlations, which were controlled for zoo property, were used to examine the relationship between visitor attitudes and how visitors rated little penguin welfare, the penguin enclosure and visitor experience.

6.4 Results

6.4.1 Demographics

A total of 638 participants completed the questionnaire, 271 were completed onsite during their zoo visit (42%; 238 at Melbourne Zoo and 33 at Taronga Zoo) while 367 were completed online after their zoo visit (58%; 257 at Melbourne Zoo and 110 at Taronga Zoo). At both zoos, most participants that completed the questionnaire were living in Australia, non-zoo members, female, were previously or currently pet owners, aged between 26-35 and had a University degree (Table 6.1). However, chi square tests (χ^2) found there were some differences in visitor demographics between the two zoos including "Residence", "Type of visitor", "Pet ownership" and "Age". At Melbourne Zoo, a greater proportion of visitors living in Australia completed the questionnaire while at Taronga Zoo nearly an equal number of both local and international visitors completed the questionnaire ($\chi^2 = 30.21$, $n = 633$, $p < 0.01$, $\phi = 0.22$; Table 6.1). Also, there was nearly a 50/50 split of zoo members and non-zoo members at Melbourne Zoo that completed the survey while more non-zoo members completed the questionnaire at Taronga Zoo ($\chi^2 = 45.94$, $n = 637$, $p < 0.01$, $\phi = 0.27$; Table 6.1). A greater proportion of pet owners at

Melbourne Zoo compared to Taronga Zoo completed the questionnaire despite at both zoos, visitors that had previously or currently owned a pet primarily completed the survey more than non-pet owners ($\chi^2 = 10.02$, $n = 637$, $p < 0.01$, $\phi = 0.13$; Table 6.1). Also, even though most participants at both zoos were aged between 26-35 years of age, there was a greater number of participants that completed the questionnaire at Melbourne Zoo aged between 26-35 and 36-45 compared to Taronga Zoo where participants were primarily aged between 18-25 and 26-35 ($\chi^2 = 11.12$, $n = 634$, $p < 0.05$, Cramer's $V = 0.13$; Table 6.1). A chi square test was also performed on "Education" which was not significant ($p > 0.05$), but it should be noted this was performed with the categories *No formal schooling*, *Primary school* and *Other education institution* removed as these categories were found to have frequencies less than 5.

Table 6.1. Comparison of demographic information of participants between the two zoos using Chi square tests (χ^2).

Demographic Factor	Melbourne Zoo	Taronga Zoo	Total	P value
Number of participants	495 (78%)	143 (22%)	638	
Residence				
Living in Australia	392	82	474 (75%)	<0.01
Overseas	98	61	159 (25%)	
Type of visitor				
Zoo member	221	19	240 (38%)	<0.01
Non-zoo member	274	123	397 (62%)	
Gender				
Male	149	45	194 (31%)	0.81
Female	345	97	442 (69%)	
Previously owned/Currently own a pet				
Yes	463	121	584 (92%)	<0.01
No	32	21	53 (8%)	
Age				
18-25	119	30	149 (24%)	<0.05

26-35	144	48	192 (30%)	
36-45	125	23	148 (23%)	
46-55	31	18	49 (8%)	
55+	73	23	96 (15%)	
Highest level of Education				
No formal school	0	1	1 (0.2%)	
Primary school	1	0	1 (0.2%)	
Secondary school	90	20	110 (17%)	
Technical or further education institution (including TAFE College)	90	27	117 (18%)	0.56
University or other higher education institution	309	91	400 (63%)	
Other education institution	5	2	7 (1.1%)	

Melbourne zoo demographic information was obtained from Chiew et al. (2019b). P-values less than 0.05 are in bold.

6.4.2 Principal Component Analyses

A total of 35 attitudinal statements were subjected to PCAs with the question items, component loadings and Cronbach's α coefficients or Inter-item correlations given in Table 2. A total of 10 attitude components were extracted and found to be consistent at each zoo, with slight variation in the loadings (Table 6.2). Note that for Melbourne Zoo, 'Positive visitor effect' and 'Neutral visitor effect' components were obtained from Chiew et al. (2019b) while the remaining extracted attitudes components were obtained from new PCAs conducted in the present study to ensure consistency with the question items that loaded on the extracted components at Taronga Zoo. The labelling of the resulting components was similar to those found in Chiew et al. (2019b) (Table 6.2).

Six individual question items including whether visitors thought little penguins are aggressive, timid, or cute and how visitors rated the welfare of the little penguins, the penguin enclosure and visitor experience at the enclosure were analysed separately and not subjected to PCAs. This was because these items either, did not reliably measure the same underlying construct when subjected to PCA or used a different rating scale to the

attitudinal statements (Table 6.3). These items were subjectively labelled as “Perceived Aggressiveness”, “Perceived Timidness”, “Perceived Cuteness”, “Welfare of the little penguins”, “Little penguin enclosure” and “Visitor experience at the penguin enclosure” (Table 6.3).

Table 6.2. Extracted attitude components at each zoo after performing PCAs and, the corresponding question items on each component, their loadings and Cronbach's α coefficients.

Extracted attitude component	Items	Melbourne Zoo (n = 495)		Taronga Zoo (n = 143)	
		Loadings	Cronbach's α	Loadings	Cronbach's α
Positive penguin characteristics	Do you think little penguins are Playful?	0.86	0.77	0.81	0.64 (Inter-item correlation = 0.31)
	Do you think little penguins are Intelligent?	0.81		0.62	
	Do you think little penguins are Friendly?	0.75		0.63	
	Do you think little penguins are Social?	0.68		0.72	
Negative penguin welfare	Do you think the penguins are Frightened?	0.89	0.83	0.89	0.87
	Do you think the penguins are Stressed?	0.85		0.74	
	Do you think the penguins are Frustrated?	0.72		0.83	
	Do you think the penguins are Anxious?	0.68		0.80	
	Do you think the penguins are Subdued?	0.64		0.75	
	Do you think the penguins are Bored?	0.54		0.51	
Positive penguin welfare	Do you think the penguins are Alert?	0.89	0.78	0.88	0.74
	Do you think the penguins are Healthy?	0.82		0.65	
	Do you think the penguins are Happy?	0.75		0.72	
	Do you think the penguins are Expressing natural behaviours?	0.62		0.63	
	Do you think the penguins are Calm?	0.40		0.56	
	Do you think the penguins find visitors Entertaining?	0.89	0.78	0.92	0.86

Positive visitor effect	Do you think the penguins find visitors Interesting?	0.88		0.91	
	Do you think the penguins find visitors Novel?	0.72		0.82	
Neutral visitor effect	Do you think the penguins find visitors NOT fear-provoking?	0.86	0.59	0.81	0.47
	Do you think the penguins are unbothered by visitors?	0.82	(Inter-item correlation = 0.43)	0.81	(Inter-item correlation = 0.31)
Positive enclosure characteristics	Do you think the penguin enclosure is Interesting to look at?	0.84		0.75	
	Do you think the penguin enclosure is Well maintained?	0.83		0.84	
	Do you think the penguin enclosure is Natural looking?	0.83	0.82	0.71	0.83
	The exhibit was engaging.	0.69		0.89	
Negative enclosure characteristics	Do you think the penguin enclosure is Restrictive?	0.92		0.92	
	Do you think the penguin enclosure is Small?	0.88	0.79	0.94	0.87
Experience with the penguins	I like being close to the penguins.	0.81		0.79	
	It was exciting to see the little penguins.	0.81		0.87	
	I like seeing the penguins active and engaging in lots of behaviours.	0.77	0.81	0.79	0.85
	It was entertaining to watch the little penguins.	0.75		0.86	
Learning	I learnt about a penguin's natural lifestyle.	0.90		0.92	
	I learnt about penguin behaviour when I was at the penguin exhibit.	0.89	0.88	0.90	0.89
	I learnt about conservation issues related to penguins	0.87		0.85	

Visual barriers	Having one-way visual barriers where penguins cannot see visitors, but visitors can see penguins improves visitors' experience.	0.90	0.76	0.94	0.86
	Having one-way visual barriers where penguins cannot see visitors, but visitors can see penguins improves penguin welfare.	0.90		0.94	

Inter-item correlations are also presented for components that had a Cronbach's α below the criterion (i.e., $\alpha < 0.70$).

6.4.3 Differences in visitor attitudes between zoos

MANOVAs were performed to examine the effect of the demographic variables on visitor attitudes. A total of 16 variables to represent visitor attitudes (i.e., the 10 extracted attitude components from PCAs and six individual question items) were used as the dependent variables. The independent variables were the demographics variables: “Residence”, “Type of visitor”, “Gender”, “Pet ownership”, “Age” and “Education. Few effects of the demographic variables on visitor attitudes were found. A significant effect of “Pet ownership” on the “Perceived Cuteness” of little penguins, “Experience with the penguins” and “Visual Barriers” was found ($F_{16,417} = 1.98$, $p < 0.05$, Wilk's Lambda = 0.93, partial $\eta^2 = 0.07$). People who were had previously or currently owned a pet had more positive attitudes that little penguins are cute ($F_{1,432} = 11.15$, $p < 0.05$, partial $\eta^2 = 0.03$) and positive attitudes towards “Experience with the penguins” ($F_{1,432} = 5.82$, $p < 0.01$, partial $\eta^2 = 0.01$) and “Visual Barriers” ($F_{1,432} = 5.50$, $p < 0.05$, partial $\eta^2 = 0.01$) compared to visitors that did not previously or currently own a pet. No interactions were found between any of the demographic variables and zoo property on visitor attitudes ($p > 0.05$).

Table 6.3 presents the scale mean scores of the 16 attitudes variables, where the higher the scale mean score, the more agreement and therefore, more positive attitude. Based on the scale mean scores, overall, visitors at both zoos had positive attitudes towards penguin characteristics, their welfare and visitor experience, neutral attitudes towards positive and neutral effects of visitors on little penguins and relatively positive attitudes towards the penguin enclosure and visual barriers (Table 6.3). When the effect of zoo property (independent variable) on the 16 attitude variables (dependent variables) was examined by performing a MANOVA, it was found that there were some significant differences in visitor attitudes between the two zoos ($F_{16,419} = 4.37$, $p < 0.01$, Wilk's Lambda = 0.86, partial $\eta^2 = 0.14$). To identify which visitor attitudes differed between the two zoos, the results for the 16 attitudes variables were considered separately through univariate analyses (Table 6.3). Visitors at both zoos tended to disagree that the penguins were frightened, stressed, frustrated, anxious, subdued, or bored (PCA component “Negative penguin welfare”) but there was a slightly higher level of agreement at Melbourne Zoo ($F_{1,434} = 7.56$, $p < 0.01$, partial $\eta^2 = 0.02$). Also, visitors at both zoos reported positive “Experience with the penguins” however, there were greater positive experiences at Taronga Zoo compared to Melbourne Zoo ($F_{1,434} = 11.76$, $p < 0.01$, partial $\eta^2 = 0.03$). This was also reflected in the overall visitor experience at the penguin enclosure, which was rated higher at Taronga Zoo compared to Melbourne Zoo ($F_{1,434} = 8.11$, $p < 0.01$, partial $\eta^2 = 0.02$). For both zoos, visitors had a fairly neutral response towards “Learning” where

visitors neither agreed nor disagreed that they learnt about a penguin's natural lifestyle, penguin behaviour and conservation issues related to penguins while at the penguin exhibit. However, visitors at Melbourne Zoo tended to disagree that they learnt about the penguins to a greater extent than did visitors at Taronga Zoo ($F_{1,434} = 16.04$, $p < 0.01$, partial $\eta^2 = 0.04$). Also, visitors at Melbourne Zoo had more positive attitudes towards "Visual barriers" compared to visitors at Taronga Zoo ($F_{1,434} = 6.00$, $p < 0.05$, partial $\eta^2 = 0.01$). There were also some significant differences in visitors' responses to individual questionnaire items. "Perceived Aggressiveness" of little penguins was higher at Taronga Zoo ($F_{1,434} = 7.89$, $p < 0.01$, partial $\eta^2 = 0.02$) although at both zoos, visitors tended overall to disagree that little penguins are aggressive. "Perceived Timidness" of little penguins was greater at Melbourne Zoo ($F_{1,434} = 13.27$, $p < 0.01$, partial $\eta^2 = 0.03$) although at both zoos, visitor tended to agree overall that little penguins are timid. Note that, partial η^2 is a measure of effect size and the values ranged from small (i.e., 0.01) to medium (i.e., 0.06) and one that was large (i.e., 0.14) (Cohen, 1988).

6.4.4 Relationship between visitor attitudes and how visitors rated little penguin welfare, the enclosure and visitor experience

When zoo property was controlled for, visitor attitudes were found to be significantly correlated with how visitors rated little penguin welfare, the enclosure and visitor experience at the penguin enclosure ($p < 0.05$; Table 6.4). Visitor attitudes towards "Positive penguin characteristics", "Positive penguin welfare", positive and neutral visitor effects, "Positive enclosure characteristics", "Experience with the penguins" and "Learning", were positively correlated with higher ratings of little penguin welfare, the enclosure and visitor experience (Table 6.4). While visitor attitudes towards "Negative penguin welfare", "Negative enclosure characteristics" and "Visual barriers" were negatively associated with how visitors rated little penguin welfare, the enclosure and visitor experience (Table 6.4). Partial correlations also showed that the individual question items related to little penguin aggressiveness, timidness and cuteness were associated with how visitors rated little penguin welfare, the enclosure and visitor experience. "Perceived Aggressiveness" and "Perceived Timidness" of little penguins were negatively correlated with how visitors rated little penguin welfare whereas "Perceived Cuteness" was positively associated with how visitors rated their experience at the penguin enclosure (Table 6.4). Note that, with the exception of "Perceived timidness", "Perceived cuteness" and "Visual barriers", correlations were within the strong correlation range, 0.60-0.79 and moderate range, 0.40-0.59, and a few in the weak range, 0.20-0.39 (Evans, 1996).

Table 6.3. Differences between Melbourne Zoo and Taronga Zoo scale mean scores and rating questions ($\pm$ standard error of the mean, SEM) identified from univariate analyses.

	Overall	Melbourne Zoo	Taronga Zoo	P value
Scale mean scores (Likert scale 1-5: 1 = strongly disagree, 5 = strongly agree)				
Positive penguin characteristics	3.88 $\pm$ 0.04	3.89 $\pm$ 0.03	3.88 $\pm$ 0.07	0.99
Perceived Aggressiveness	1.95 $\pm$ 0.06	1.79 $\pm$ 0.04	2.11 $\pm$ 0.11	<0.01
Perceived Timidness	3.32 $\pm$ 0.06	3.55 $\pm$ 0.05	3.10 $\pm$ 0.11	<0.01
Perceived Cuteness	4.55 $\pm$ 0.05	4.47 $\pm$ 0.04	4.63 $\pm$ 0.09	0.09
Negative penguin welfare	2.47 $\pm$ 0.04	2.59 $\pm$ 0.03	2.36 $\pm$ 0.08	<0.01
Positive penguin welfare	3.74 $\pm$ 0.04	3.71 $\pm$ 0.03	3.77 $\pm$ 0.07	0.40
Positive visitor effects	2.82 $\pm$ 0.05	2.79 $\pm$ 0.04	2.85 $\pm$ 0.09	0.54
Neutral visitor effects	3.30 $\pm$ 0.05	3.23 $\pm$ 0.04	3.36 $\pm$ 0.10	0.20
Positive enclosure characteristics	3.57 $\pm$ 0.05	3.49 $\pm$ 0.04	3.65 $\pm$ 0.10	0.13
Negative enclosure characteristics	2.99 $\pm$ 0.06	2.99 $\pm$ 0.05	2.99 $\pm$ 0.12	0.97
Experience with the penguins	4.13 $\pm$ 0.06	3.99 $\pm$ 0.03	4.27 $\pm$ 0.08	<0.01
Learning	3.04 $\pm$ 0.06	2.78 $\pm$ 0.05	3.30 $\pm$ 0.12	<0.01
Visual barriers	3.53 $\pm$ 0.06	3.67 $\pm$ 0.04	3.40 $\pm$ 0.10	<0.05
Rating questions (scale 1-10: 1 = very poor, 10 = excellent)				
Welfare of the little penguins	7.68 $\pm$ 0.12	7.59 $\pm$ 0.09	7.77 $\pm$ 0.22	0.44
Little penguin enclosure	7.02 $\pm$ 0.14	6.97 $\pm$ 0.11	7.07 $\pm$ 0.26	0.73
Visitor experience at the penguin enclosure	6.96 $\pm$ 0.15	6.55 $\pm$ 0.11	7.37 $\pm$ 0.27	<0.01

P-values less than 0.05 and 0.01 are in bold.

Table 6.4. Partial correlations between visitor attitudes and how visitors rated little penguin welfare, the enclosure and visitor experience.

	Welfare of the little penguins	Little penguin enclosure	Visitor experience at the penguin enclosure
Positive penguin characteristics	0.14**	0.21**	0.28**
Perceived Aggressiveness	-0.12**	-0.12**	-0.17**
Perceived Timidness	-0.10*	-0.07	-0.05
Perceived Cuteness	0.06	0.08	0.18**
Negative penguin welfare	-0.43**	-0.44**	-0.44**
Positive penguin welfare	0.54**	0.55**	0.59**
Positive visitor effects	0.27**	0.29**	0.26**
Neutral visitor effects	0.29**	0.27**	0.26**
Positive enclosure characteristics	0.47**	0.70**	0.66**
Negative enclosure characteristics	-0.44**	-0.60**	-0.46**
Experience with the penguins	0.34**	0.38**	0.46**
Learning	0.34**	0.43**	0.52**
Visual barriers	-0.09*	-0.15**	-0.10*

*Correlation is significant at the 0.05 level (2-tailed).

**Correlation is significant at the 0.01 level (2-tailed).

6.5 Discussion

The same attitude components were extracted at both zoos which suggests that the attitude dimensions of visitors were stable between the two zoos. This indicates that these measures of attitudes were stable over time and location. In other words, it suggests that visitors at the two zoos evaluated little penguins, penguin welfare, visitor effects, the enclosure, learning, visual barriers, and visitor experience in a similar manner, resulting in similar visitor attitudes, or more specifically visitor beliefs. This is the cognitive component of attitudes that was assessed in the present study to infer the attitudes of visitors. Overall, visitors at both zoos had positive attitudes towards little penguins, evident through the positive visitor beliefs that little penguins are playful, intelligent, friendly, and social and were in a positive welfare state. Visitors also generally had neutral attitudes towards positive and neutral effects of visitors on little penguins and learning, and relatively positive attitudes towards the penguin enclosure and visual barriers. We also found that the more positive visitor attitudes were towards penguins, their welfare, the enclosure, experience with the penguins and learning, the higher visitor ratings were for penguin welfare, the enclosure and visitor experience. Our results align with previous research that also indicates zoo visitors have positive attitudes towards zoo animals and their enclosures when zoos provide positive experiences for visitors (Woods, 2002; Clayton et al., 2009; Miller et al., 2013; Yilmaz et al., 2017). Consequently, the present study results are encouraging for both zoos as it suggests the two zoos are providing positive experiences for visitors at the penguin exhibit that may be related to positive visitor attitudes which is important for the overall ethical foundation of zoos (Maple and Perdue, 2013; Sherwen et al., 2018). However, despite these positive attitudes, there is evidence at both zoos that close visitor contact increases avoidance of visitors in little penguins (Chiew et al., 2019a; Chiew et al., 2020).

Visitor attitudes were surveyed in conjunction with our experiments that investigated the effects of regulating visitor contact on little penguin behaviour at Melbourne and Taronga Zoo (Chiew et al., 2019a; Chiew et al., 2020). Visitor contact was regulated by making alterations or manipulations to the exhibit which included, a physical barrier placed 2 m from the enclosure at Melbourne Zoo and a visual barrier that obstructed the view between visitors and penguins at a single viewing window at Taronga Zoo (Chiew et al., 2019a; Chiew et al., 2020). Chiew et al. (2019a) found that the close viewing proximity of visitors can be fear-provoking for little penguins at Melbourne Zoo, shown by the increased number of penguins huddling, vigilant, avoiding the visitor viewing area and decreased number of penguins surface swimming. The close visitor viewing proximity

also increased intense visitor behaviours including looming over the pool ledge, sudden movement, and tactile contact with the pool's water. In comparison, little penguins at Taronga Zoo showed some avoidance of the main visitor viewing window when visitor contact was not obstructed, indicated by the reduced presence, reduced preening in the water and increased vigilance by little penguins in the area near this main window (Chiew et al., 2020). The unobstructed window also allowed visitors to view the penguins up close and engage in potentially fear-provoking behaviours such as banging on the window, loud vocalisations, and sudden movement at this window (Chiew et al., 2020). Despite the intense and potentially fear-provoking visitor behaviours observed at the two zoos which were likely perceived by little penguins as threatening, visitors had positive attitudes towards little penguins, their welfare, the enclosure, experience with the penguins and visual barriers. Visitors also overall rated their experience at the enclosure relatively high. This suggests that the positive visitor attitudes and experience found in the present study, may be increasing these intense and potentially negative behaviours in visitors towards penguins which contrasts with the research on stockperson-animal relationships and the handful of studies that have found positive visitor attitudes towards wildlife may reduce intense and harmful behaviours towards wildlife (Blaney and Wells, 2004; Barney et al., 2005; Hemsworth and Coleman, 2011; Pearson et al., 2014b; Munoz et al., 2019). It is possible that the positive visitor attitudes and positive visitor experience found in the present study may have increased visitors' desire to interact or be in close contact with penguins. Thus, this may have motivated visitors to engage in behaviours to seek the penguins' attention which visitors may not be aware may be perceived as threatening for the penguins (Chiew et al., 2019b). The potential lack of awareness of visitor effects on little penguins is consistent with the neutral visitor attitudes towards positive and neutral visitor effects found in the present study (i.e., neither agreed nor disagreed). This could be addressed by effective communication and educational strategies to raise visitor awareness about visitor effects or alter visitor attitudes and perceptions of interacting with zoo animals (Chiew et al., 2019b; Learmonth, 2020). However, we were not able to directly correlate the attitudes of each visitor with their behaviour and did not examine visitors' attitudes specifically toward the behaviours that they, as visitors, engage in towards little penguins. Consequently, further research on visitor attitudes and their link with visitor behaviour towards zoo animals is still required.

Even though the overall attitudes of visitors at both zoos were positive, there were some differences in visitor attitudes between the zoos. The visitor attitudes that differed between the two zoos were attitudes towards the perceived 'aggressiveness' and

'timidness' of little penguins, 'negative penguin welfare', 'experience with the penguins', 'learning', 'visual barriers' and the way visitors rated their overall experience at the penguin enclosure. Why only these seven, out of 16, attitudes specifically differed is unclear but suggests that visitors at the two zoos likely had different perceptions of the enclosures, behaviour of the little penguins and their experience at the enclosure. However, it is well understood that attitudes towards animals can vary as a result of variation in demographic, socioeconomic and cultural factors as well as past experiences with animals (Bjerke et al., 2003; Taylor and Signal, 2005; Prokop and Tunnicliffe, 2010; Clucas and Marzluff, 2012). Some of these factors may explain some of the differences in visitor attitudes and visitor experience between the zoos in the present study. There were some slight differences in visitor demographics at the two zoos where participants that completed the questionnaire at Melbourne Zoo were primarily locals living in Australia, were balanced between zoo members and non-zoo members, had a greater proportion of pet owners or people who had previously owned a pet and participants aged between 26-35 and 36-45 years old compared to participants at Taronga Zoo. These differences in demographics may have been responsible for the differences in visitor attitudes and experience between the zoos. However, in the MANOVAs, no interactions between the demographic variables and zoo property were found which suggests the differences in visitor attitudes and visitor experience were not attributable to the differences between the two zoos in visitor demographics.

As previously mentioned, visitors in the present study were surveyed in conjunction with our studies that examined the effects of regulating visitor contact on little penguin behaviour by using exhibit manipulations which may have affected the differences in visitor attitudes and experience between the two zoos. Indeed, Chiew et al. (2019b) found that regulating visitor-penguin interactions using a physical barrier placed 2 m from the penguin exhibit and signs, affected some visitor attitudes at Melbourne Zoo, particularly attitudes towards positive penguin characteristics, neutral visitor effects and physical barriers. However, the physical barrier and signs had no effect on other visitor attitudes such as attitudes towards penguin welfare, the enclosure, visitor experience and the way visitors rated these items. This suggests there was no detrimental impact on the overall attitudes towards little penguins, the enclosure and visitor experience when using a physical barrier and signs to regulate visitor-penguin interactions (Chiew et al., 2019b). While not specifically examined in the present study, exploratory analyses found no interaction between having a barrier present (physical or visual) and zoo property. This suggests the differences in visitor attitudes and experience between the two zoos are unlikely to have been influenced by the exhibit manipulations at each zoo. Interestingly,

more positive attitudes towards visual barriers were found at Melbourne Zoo compared to visitor attitudes at Taronga Zoo. This may be because no visual barriers were used to regulate visitor-penguin interactions at Melbourne Zoo and no detrimental impact of a physical barrier or signs was found on visitor experience (Chiew et al., 2019a; Chiew et al., 2019b). In comparison, a visual barrier was used at Taronga Zoo which reduced the view of penguins at a single visitor viewing window (Chiew et al., 2020).

The exhibit manipulations at the two zoos may not have influenced the differences in visitor attitudes and experience between the zoos per se, but the changes in zoo animal behaviour as a result of these manipulations may have. For example, camouflage netting installed onto the viewing area of the exhibit was found to reduce conspecific-directed aggression and stereotypic behaviour in gorillas and improved visitor perceptions of gorillas where they were perceived as more exciting and less aggressive (Blaney and Wells, 2004). The improvement in visitor perceptions may not have been only because of the presence of the camouflage netting but also the change in gorilla behaviour as a result of the netting. Consequently, the behaviour of penguins at the two zoos may be a factor that influenced the differences in visitor attitudes and experience between the zoos. Several studies have shown animal behaviour can influence the attitude of visitors and visitor experience. Zoo animals that are the active and behaviourally diverse are associated with increased positive visitor perceptions of animals, visitor experience and increased self-reported positive affective responses and conservation intent in visitors (Anderson et al., 2003; Godinez et al., 2013; Hacker and Miller, 2016; Luebke et al., 2016). Recently, Chiew et al. (2019b) also showed that little penguin behaviour is correlated with visitor attitudes. When little penguins at Melbourne Zoo were more visible, active (e.g., swimming and diving) and close to the visitor viewing area, visitors had more positive attitudes towards little penguins, penguin welfare, visitor effects, the enclosure, learning, experience, and exhibit manipulations and, rated higher the welfare of the penguins, the enclosure and visitor experience at the penguin exhibit (Chiew et al., 2019b). Consequently, in the present study, the behaviour of little penguins at each zoo may have influenced the differences in visitor attitudes and experience between the zoos. Further analyses to examine the relationship between penguin behaviour and visitor attitudes particularly at Taronga Zoo needs to be conducted to determine if similar relationships to those found at Melbourne Zoo exist. Nevertheless, it is more likely that these differences in visitor attitudes and experience between the zoos are the result of the intrinsic differences in enclosure design and the subsequent variation in visitor-penguin interactions at the two zoos.

Both zoos differed quite dramatically in the design of their penguin enclosures which influenced the type of interactions that were possible between the visitors and little penguins. At Melbourne Zoo, the design of the enclosure allowed visitors to view the penguins from three sides of the enclosure, with the main length of the pool being the common viewing area and where there were opportunities, if visitors chose, to make tactile contact with the pool by looming over the pool edge (Chiew et al., 2019a). Chiew et al. (2019a) found that the close viewing proximity of visitors had a pronounced effect on little penguin fear responses to visitors at Melbourne Zoo. But penguin fear responses were reduced when visitors were further away from the enclosure by using a physical barrier (Chiew et al., 2019a). At Taronga Zoo, the penguin enclosure was long and narrow, had a long watercourse and elongated stretch of land where the visitor viewing area was limited to one side of the enclosure, positioning visitors below penguins and allowed visitors to primarily view penguins underwater through tall glass windows (Chiew et al., 2020). As previously described, there was evidence of some avoidance of visitors by little penguins when visitor contact was not obstructed by a visual barrier at Taronga Zoo. This suggests that visitor contact also had an effect on little penguin fear responses at Taronga Zoo. But in comparison to the penguins at Melbourne Zoo, the penguin fear responses at Taronga Zoo were less pronounced because of the design of the Taronga Zoo penguin enclosure that helped minimise visitor contact by restricting the viewing area to one side of the enclosure and provided a retreat area where penguins were visually hidden from visitors. Consequently, it is possible that these differences in enclosure design and visitor-penguin interactions at the two zoos may explain some of the differences in visitor attitudes and visitor experience between the zoos. Studies that have examined the effects of enclosures on zoo visitors has primarily focused on the effects of naturalistic vs. non-naturalistic enclosures (Rhoads and Goldsworthy, 1979; Finlay et al., 1988; Melfi et al., 2004; Nakamichi, 2007; Mun et al., 2013; Luebke et al., 2016). But research has yet to examine the effects of other characteristics of enclosures on visitors such as the position of visitors relative to the animals while viewing animals, restriction of the visitor viewing area to one side vs. all sides of an enclosure or the presence or absence of glass viewing windows. Further examination of the specific exhibit design characteristics that may be influencing the positive, neutral, and negative visitor attitudes observed in the present study is recommended.

It should be noted that the magnitudes of the significant differences in attitudes (i.e., the scale mean scores) observed in the present study are numerically small, ranging from 0.23 to 0.52 (for the 5-point Likert scale variables) and differed by about 0.80 for visitor experience ratings (out of 10) at the enclosure. Furthermore, the effect sizes (partial η^2)

mostly ranged from small to medium (i.e., 0.01 to 0.06). However, it is unclear what the practical implications of our results are because it is not possible to interpret the absolute magnitude of these measures. Comparisons would need to be made between a larger number of zoos or enclosures that are more markedly different than the penguin enclosures at the two zoos studied here to permit a better understanding of the basis for the differences in attitudes. This is because visitors at each zoo appeared to view the enclosures similarly shown by the enclosures being rated positively at both zoos, scoring approximately 7/10. Yet, the penguin enclosures at the two zoos did differ in design, especially in terms of how visitors were able to see and interact with the penguins. At Taronga Zoo, visitors viewed penguins up close while the penguins were in the pool compared to Melbourne Zoo where visitors primarily viewed penguins from afar because the penguins were mostly withdrawn on land. Consequently, further investigation to understand what animal and enclosure characteristics are important to visitors that may be similar across zoos is needed to determine the practical implications of these differences in visitor attitudes.

While the results from the present study cannot specifically be extrapolated to other zoos, it does provide an approach that can be extrapolated to examine visitor attitudes in conjunction with the effect of visitors on zoo animals. This type of approach has yet to be extended to other zoo species but is a promising avenue to help better manage visitor-animal interactions by understanding both sides of the zoo visitor-animal relationship. Our results also provide valuable insight into visitor attitudes towards an understudied zoo species, little penguins, and visitor experience at two Australian zoos and, a foundation for future research to build upon which can be applied at other zoos. In particular, our study has highlighted the need for further examination of the relationship between visitor attitudes and the behaviour of visitors towards zoo animals and how visitors assess zoo animal welfare, animal enclosures and their experience at exhibits. These suggestions for future research are important because firstly, human behaviour can significantly affect animal welfare (Hemsworth et al., 2018; Sherwen and Hemsworth, 2019). Therefore, understanding the attitudes that may influence human behaviour towards animals can help develop human behaviour change interventions to continuously improve the lives of animals not only in zoos but across the different animal industries (Coleman, 2010; Hemsworth et al., 2018; Glanville et al., 2020). Secondly, the present study found ratings for penguin welfare, the enclosure and visitor experience were only moderately high and attitudes towards learning were fairly neutral at both zoos. A number of studies have found that visitors assess animal welfare based on aesthetics like enclosure style and the expression of active behaviours (e.g., play, climbing

and eating behaviours) where the more naturalistic an enclosure looks and active an animal is, the better visitors perceived the welfare of the animal (Rhoads and Goldsworthy, 1979; Finlay et al., 1988; Melfi et al., 2004; Nakamichi, 2007; Luebke et al., 2016; Chiew et al., 2019b). While visitors are not specifically qualified to make robust assessments of animal welfare or other aspects of the zoo, understanding how visitors rate zoo animal welfare, enclosures and their experience and what visitors are learning while at zoos is still valuable. Through this type of information, zoos can identify areas of improvement and develop strategies, for example, to enable visitors to make more informed judgements about animal welfare and zoo enclosure design or enhance visitor knowledge of the potential effects visitors can have on zoo animals (Melfi et al., 2004; Coleman, 2010).

6.6 Conclusions

This study is the first study, to our knowledge, that compared the attitudes of visitors, by assessing the cognitive (belief) component of attitudes, towards zoo-housed little penguins, their enclosure and visitor experience at two Australian zoos. There were some differences in visitor attitudes and visitor experience between the two zoos. While the reasons for these differences were not clear, they did not appear to be due to visitor demographics or the exhibit manipulations imposed at each zoo. It is possible that the differences may be attributable to the enclosures themselves which differed in their design and influenced the way penguins behaved and how visitor interacted with the penguins, despite both enclosures were perceived relatively positively at both zoos. Nevertheless, this study found visitors at both zoos, overall, had positive attitudes towards the little penguins, penguin welfare, the enclosure and visitor experience which was related to higher visitor ratings of the welfare of the penguins, enclosure, and visitor experience at the enclosure. But it remains unclear how these positive attitudes and positive visitor experience may be influencing the way visitors behave towards zoo-housed little penguins. Results from this study have increased our understanding of visitor attitudes towards little penguins and visitor experience at two Australian zoos and provides a foundation for future research to build upon.

Data Availability Statement: The datasets generated for this study are available on request to the corresponding author.

Ethics Statement: The studies involving human participants were reviewed and Q8 approved by the Veterinary and Agricultural Sciences Human Ethics Advisory Group, Faculty of Veterinary and Agricultural Sciences, University of Melbourne, Australia

(Ethics Application 1545739.1 and 1545739.3). The patients/participants provided their written informed consent to participate in this study.

Author Contributions: SC, PH, SS, VM, AB and GC designed the study. GC, SS and AB assisted with focus groups at Melbourne Zoo and Taronga Zoo, respectively. SC, with assistance from SS and AB, liaised with the keepers and other zoo staff at both Melbourne and Taronga Zoo. SC organised and carried out the data collection with the help of student volunteers, interns, and research assistant from the Animal Welfare Science Centre (University of Melbourne, Australia), who were also organised and trained by SC. SC collated all data and with the aid of GC, performed the statistical analyses of the data and interpretation. SC wrote the paper. GC, PH, VM, SS and AB provided feedback and additions to the paper.

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Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Chapter 7

General Discussion and Conclusions

This chapter summarises the main objectives and findings of this thesis. It also discusses the variation across the three zoos, the possible influencing factors for this variation and implications of the findings of this thesis for the zoo industry. Furthermore, this chapter discusses the research limitations and makes suggestions for future research.



7.1 Reviewing the aims of the thesis

The zoo visitor-animal relationship is defined as the history of interactions between zoo animals and visitors where each individuals' perception of the relationship allows them to interpret and predict future interactions with one another. Research on the zoo visitor-animal relationship has substantially increased over the past several decades. Yet, understanding both sides of the visitor-animal relationship is still limited. In particular, the manner in which visitors affect zoo animals and the effect of zoo animals on visitors remains poorly understood, especially for the understudied species, little penguins. Therefore, this thesis examined both sides of the visitor-penguin relationship in which little penguins were the focal species.

The aim of this thesis was to determine the effects of regulating the interactions between zoo visitors and little penguins, on both the penguins and visitors at display enclosures. The specific objectives of this thesis included:

- To determine the effects of regulating visitor-penguin interactions on little penguin behaviour and stress physiology.
- To determine how regulating visitor-penguin interactions affects visitor behaviour, attitudes, and their experience.
- To determine visitor attitudes towards zoo-housed little penguins and visitor experience that may influence the way visitors behave towards little penguins.
- To provide advice, based on the findings of this thesis, on management strategies to improve the welfare of zoo-housed little penguins and visitor experience.

To achieve these objectives, the visitor-penguin relationship was examined at three zoos by assessing the behavioural and physiological response of little penguins towards visitors, in conjunction with the assessment of visitor behaviour, attitudes and their experience. Firstly, the effects of regulating different aspects of visitor contact on little penguin behaviour and stress physiology as well as visitor behaviour were examined at each zoo. At Melbourne Zoo, the effects of regulating the viewing proximity of visitors to the enclosure and the intensity of visitor behaviour on little penguin behaviour and stress physiology were examined (Chapter 2). At Taronga Zoo, a single visitor viewing window was covered using a visual barrier to examine the effects of unobstructed visitor contact on little penguin behaviour (Chapter 3). At Wellington Zoo, the opening and closing of the penguin exhibit to visitors was used to examine the effects of the presence and absence of visitors on little penguin behaviour and stress physiology (Chapter 4). Secondly, an attitude questionnaire to assess the attitudes and experience of visitors in

conjunction with the penguin studies at Melbourne and Taronga Zoo, was developed from focus groups with zoo visitors (Chapter 5 and 6). The questionnaire was used to examine: 1. the relationship between penguin behaviour and the attitudes and experience of visitors, to understand the possible effects of little penguins on visitors; 2. the effects of regulating visitor-penguin interactions on visitor attitudes and experience; and 3. the attitudes and experience of visitors that may influence the way they behave towards zoo animals (Chapter 5 and 6). These two chapters provide insights into the underlying beliefs of visitors towards little penguins, penguin welfare, enclosure design, visitor effects, enclosure manipulations and experience at the penguin enclosures. The difference between Chapter 5 and 6 is that Chapter 5 determined the effect of penguin behaviour and regulating visitor-penguin interactions using exhibit manipulations on visitor attitudes and experience. However, Chapter 6 identified and compared the attitudes and experience of visitors that may influence the way they behave towards little penguins at the two Australian zoos.

While the results of this thesis are restricted to only three zoos, some practical implications were identified and may be applied to better manage interactions between visitors and little penguins in both wild and zoo settings globally. This is because there were similarities in little penguin responses to visitors and in the attitudes and experience of visitors across the study zoos that may be broadly applicable worldwide.

7.2 Main findings across the three zoos

The main results of this thesis indicate that visitors may be fear-provoking for little penguins across zoos. This was determined by using common behavioural indicators of fear such as huddling, vigilance and avoidance and reductions in highly motivated behaviours such as swimming and comfort behaviours such as preening (Ainley 1974; Gray 1987; Dawkins 1988; Delius 1988; Dawkins 2004; Hemsworth and Coleman 2011; Zimmerman *et al.* 2011; Hemsworth *et al.* 2018; Sherwen and Hemsworth 2019).

At Melbourne Zoo (Chapter 2), the main visitor viewing area was along the main length of the pool where visitors had opportunities to loom above little penguins when in the pool. As a result, the close viewing proximity of visitors to the enclosure was found to fear-provoking for little penguins at Melbourne Zoo. This was evident through the increased number of penguins huddling, vigilant and avoiding the visitor viewing area and, the decreased number of penguins surface swimming and preening in the water when visitors were close to the enclosure compared to when they were further away. However, little penguin fear responses can be minimised by increasing the distance

between visitors and little penguins. This was demonstrated by the physical barrier used at Melbourne Zoo that effectively increased the distance between visitors and little penguins and regulated potentially fear-provoking visitor behaviours such as looming, tactile contact with the pool water and sudden movement. No effect of treatment was found on little penguin FGM concentrations at Melbourne Zoo.

At Taronga Zoo (Chapter 3), there was evidence that unobstructed visitor contact may be fear-provoking for little penguins. This was shown by the reduced presence and number of penguins preening in the water and increased vigilance when the main window was not covered by a visual barrier compared to when it was covered. There was also a general preference by the penguins for the corner area which was visually hidden from visitors. These penguin behavioural changes may have been the result of close visual contact of visitors and/or certain visitor behaviours occurring at this window, such as banging on the window, loud vocalisations, and sudden movement, that may be perceived as fear-provoking for little penguins when this window was not covered. However, the visual barrier not only eliminated visual contact but also minimised the occurrence of potentially fear-provoking visitor-induced sounds and vibrations. Therefore, visual barriers may have the potential to minimise little penguin fear responses to visitors. It should be noted that the visitors at Taronga Zoo were generally positioned below the surface of the penguin pool which may have minimised their impact on the penguins. FGM concentrations were also not measured at Taronga Zoo because most eliminative behaviour by penguins occurred in the pool.

At Wellington Zoo (Chapter 4), visitors were also found to be potentially fear-provoking for little penguins. This was shown by penguins increasing their avoidance of the visitor viewing pier when visitors were present compared to when they were absent. Also, similar to Melbourne Zoo, no effect on little penguin FGM concentrations were found at Wellington Zoo. The visitor viewing pier was the main section of the visitor viewing area utilised the most by visitors to view the penguins in the enclosure. The pier also positioned visitors above the pool and allowed close viewing proximity to the penguins. Therefore, little penguins may be fearful of close visitor viewing proximity.

When evaluating the results from the visitor questionnaires, conducted at Melbourne and Taronga Zoo, visitors at both zoos were found to have overall positive attitudes (Chapter 5 and 6). These positive attitudes were towards little penguins, the welfare of penguins, the enclosure and experience with the penguins which were related to higher visitor ratings of penguin welfare, the penguin enclosure, and visitor experience at the enclosure (Chapter 5 and 6). A relationship between little penguin behaviour and visitor attitudes

was also found at Melbourne Zoo. The more visible, active, and close the penguins were to the visitor viewing area, the more positive visitor attitudes were towards positive little penguin characteristics, penguin welfare, visitor effects, the enclosure, learning, visitor experience and exhibit manipulations (Chapter 5). This shows that little penguins may have a positive influence on visitor attitudes and their experience. In comparison, when correlations between little penguin behaviour and visitor attitudes and their experience at Taronga Zoo were conducted, minimal to no relationship was found. This was likely influenced by the intrinsic differences in enclosure design between Melbourne and Taronga Zoo such as the viewing position of visitors and pool design. The enclosure differences influenced the types of interactions possible between visitors and little penguins and therefore, the nature and intensity of visitor contact. In regard to regulating the interactions between visitors and little penguins, a physical barrier and/or signs and a visual barrier were found to have little to no effect, respectively, on the attitudes and experience of visitors (Chapter 5 and 6). It therefore highlights that practical measures, such as physical or visual barriers, are feasible strategies to improve the welfare of penguins without compromising visitor experience. There were some differences between the zoos in visitor attitudes towards the perceived 'aggressiveness' and 'timidness' of little penguins, 'negative penguin welfare', 'experience with the penguins', 'learning', 'visual barriers' and the way visitors rated their overall experience at the penguin enclosure (Chapter 6). However, it is unclear whether the overall positive visitor attitudes and experience at both Australian zoos influenced the way visitors behaved towards little penguins (Chapter 6).

While the results across the three zoos suggests that visitors may be fear-provoking for zoo-housed little penguins, these responses varied in magnitude. To compare the magnitude of the little penguin fear responses, a focus on the treatments that were similar across the zoos will be discussed. These treatments were the presence and absence of visitors at Melbourne and Wellington Zoo (i.e., the exhibit was open or closed to visitors) and the unobstructed and obstructed contact with visitors at the main visitor viewing window (i.e., the main window was uncovered or covered by the visual barrier) at Taronga Zoo. Even though imposing a visual barrier at Taronga Zoo was limited to a single visitor viewing window and is not the same as visitor absence, it does reflect similar conditions to visitor absence. This is because the visual barrier eliminated visual contact between the penguins and visitors and minimised visitor-induced sounds and vibrations at this window. Therefore, a comparison can be drawn between the three zoos. Also, avoidance behaviour is a well-established principal indicator of fear of humans by animals and was measured at all three zoos (Hemsworth and Coleman 2011; Hemsworth

et al. 2018; Sherwen and Hemsworth 2019). And so, when comparing the results described in Chapter 2, 3 and 4, the most pronounced fear response by little penguins towards visitors, based on avoidance behaviour, was found at Melbourne Zoo, followed by the penguins at Wellington Zoo and lastly, Taronga Zoo.

Little penguin fear responses towards visitors at Melbourne Zoo were the most pronounced compared to Wellington and Taronga Zoo. This was indicated by the increased number of visible penguins avoiding the main visitor viewing area by 2700% when visitors were present compared to when they were absent (Chapter 2). In comparison, at Wellington Zoo there was an approximate 800% increase in the number of visible penguins avoiding of the main visitor viewing section of the exhibit (i.e., the pier) when visitors were present compared to absent (Chapter 4). This penguin avoidance response to increased visitor contact at Wellington Zoo was also considered to indicate a marked effect of visitors but less pronounced compared to the penguins at Melbourne Zoo. This was because of the percentage increase in avoidance was less than that of the Melbourne Zoo penguins (800% compared to 2700%). Also, avoidance was the only penguin behaviour affected at Wellington Zoo compared to Melbourne Zoo. The least pronounced fear response by little penguins out of the three zoos was at Taronga Zoo. This was shown by only a 25% increase in the number of visible penguins avoiding of the main visitor viewing area window when this main window was uncovered compared to when it was covered (Chapter 3). But this was likely influenced by the design of the Taronga Zoo penguin enclosure which provided an area visually hidden from visitors that was a preferred area for the penguins. The penguins at Taronga Zoo also increased vigilance by about 65% and reduced preening in the water by about 180% in the area near the main visitor viewing window when this window was uncovered compared to when it was covered. While more penguin behaviours were affected at Taronga Zoo compared to Wellington Zoo, vigilance may not be an indicator of fear and could indicate curiosity (Beauchamp 2017; Sherwen and Hemsworth 2019). The increase in avoidance behaviour by the Taronga Zoo penguins was also less than that of the Wellington Zoo penguins which may have been limited by only a single visitor viewing window being covered by the visual barrier. Therefore, penguin responses at Taronga Zoo were the least pronounced potentially because visitors could still view penguins at other windows even when the visual barrier was in place and there was an area constantly available for penguins to visually hide from visitors.

Nevertheless, results from all three zoos demonstrate that close visitor contact may be fear-provoking for little penguins. Therefore, penguins in zoos may benefit from modifications to the enclosure that may ameliorate fear responses to visitors such as one-

way viewing glass, barriers that reduce close visitor contact and areas for penguins to retreat from visitors if they choose to. These modifications will result in improvements in penguin welfare and have no detrimental effect on the attitudes and experience of visitors, which were overall positive and enhanced by penguins displaying fewer behaviours indicative of fear (e.g., avoidance) and more behaviours that were active (e.g., swimming and diving).

7.3 Possible factors that influenced the differences in little penguin responses and visitor attitudes and experience between the zoos

The variation in the magnitude of little penguin fear responses to visitors and differences in some visitor attitudes and experience across the zoos may be due to a number of different factors. Therefore, this section will discuss the potential influencing factors identified that may have influenced the variation in little penguin responses to visitors and the attitudes and experience of visitors across the zoos. Some of the possible influencing factors for the variation between zoos have also been discussed in Chapters 3, 4, 5 and 6.

7.3.1 Experimental design: Exhibit manipulations

One of the key factors that may have influenced the variation in little penguin fear responses towards visitors and visitor attitudes and experience across the zoos, is the differing experimental designs. As a result of the different exhibit manipulations (i.e., the treatments) that were implemented and the length of each treatment period (i.e., the number of days) that was imposed, different aspects of visitor contact were regulated and altered at each zoo. At Melbourne Zoo, a physical barrier and/or signage was used to regulate close visitor viewing proximity and the intensity of visitor behaviour, respectively (Chapter 2). At Taronga Zoo, a visual barrier was placed only on a single visitor viewing window to regulate visitor contact at this window, particularly visual contact between visitors and penguins (Chapter 3). At Wellington Zoo, the penguin exhibit was either open or closed to visitors to regulate visitor presence and absence, respectively (Chapter 4). Therefore, it may have been the different exhibit manipulations and the number of days that these manipulations were imposed for that affected the variation in little penguin behaviour and stress physiological responses to visitors across zoos.

For visitor attitudes and experience, the physical barrier and/or signage imposed at Melbourne Zoo had some effect on certain visitor attitudes including attitudes towards

‘positive penguin characteristics’, ‘neutral visitor effects’ and ‘physical barriers’ (Chapter 5). But there was no detrimental effect of the physical barrier and/or signage on the overall attitudes of visitors towards penguin welfare and the enclosure as well as visitor experience (Chapter 5). At Taronga Zoo, no effect of the visual barrier was found on visitor attitudes or their experience. This lack of effect of the visual barrier on visitor attitudes and their experience may be because the visual barrier was limited to a single viewing window (out of four) and the visual barrier was only imposed for 1-day periods compared to 2-day periods for the treatments imposed at Melbourne Zoo. Furthermore, as discussed in Chapter 6, there were some differences in the attitudes and experiences of visitors between the two Australian zoos which included attitudes towards the perceived ‘aggressiveness’ and ‘timidness’ of little penguins, ‘negative penguin welfare’, ‘experience with the penguins’, ‘learning’, ‘visual barriers’ and the way visitors rated their overall experience at the penguin enclosure. The different exhibit manipulations imposed at each zoo may explain the differences found in visitor attitudes and their experience between Melbourne and Taronga Zoo (Chapter 6).

7.3.2 Enclosure design

Another key factor that may have influenced little penguins’ responses to visitors and the visitors themselves across the zoos, is the differing enclosure designs. As highlighted in Chapter 1, research has shown that enclosure design is an important factor that can influence both the behaviour and welfare of zoo animals and visitor behaviour, attitudes, and experience (Bitgood *et al.* 1988; Margulis *et al.* 2003; Melfi *et al.* 2004; Davey 2006b; Fernandez *et al.* 2009; Moss *et al.* 2010; de Young *et al.* 2011; Fanson and Wielebnowski 2013; Mun *et al.* 2013; Lewis *et al.* 2017; Miller *et al.* 2018; Godinez and Fernandez 2019; Sherwen and Hemsworth 2019). The design of each of the three penguin enclosures differed quite dramatically.

At Melbourne Zoo, the penguin enclosure was designed in a way that allowed visitors to view the penguins up close from all sides of the enclosure, with the main length of the pool being the common viewing area. As a result of, visitors at Melbourne Zoo had opportunities, if they chose, to make tactile contact with the pool by looming over the pool edge (Chapter 2). This may explain why there were pronounced effects of the close viewing proximity of visitors on little penguin fear responses to visitors at Melbourne Zoo. In comparison, the design of the Taronga Zoo penguin enclosure was long and narrow, with a long watercourse and elongated stretch of land and the visitor viewing area was restricted to one side of the enclosure (Chapter 3). While in the viewing area, visitors at Taronga Zoo were primarily positioned below penguins where the penguins

were viewed mostly underwater through tall glass windows. The Taronga Zoo penguin enclosure also provided an area for the penguins to retreat to, if they chose, that was visually hidden from visitors. The characteristics of the Taronga Zoo penguin enclosure may have helped minimise close visitor contact by providing more choice and control for penguins and explain the less pronounced fear response in little penguins at this zoo compared to Melbourne Zoo.

Interestingly, Wellington Zoo's penguin enclosure had characteristics that were similar to both the Melbourne and Taronga Zoo penguin enclosures. For example, like Melbourne Zoo, the Wellington Zoo penguin enclosure had opportunities for visitors in the main viewing area (i.e., the pier), if they chose, to closely approach and loom over the pool (Chapter 4). However, Wellington Zoo's penguin enclosure also had areas that were heavily vegetated and contained physical structures such as a partially upturned boat and nest boxes, particularly in Zone 3. This zone with its structures and distance from the visitor viewing pier, likely provided both physical and visual separation from visitors for the little penguins, similar to Taronga Zoo's 'Corner' area of the penguin enclosure. Thus, little penguin fear responses to visitors at Wellington Zoo were more pronounced compared to the penguins at Taronga Zoo likely because of the opportunities for close visitor viewing proximity that were similar to those at Melbourne Zoo (Chapter 4). But the fear response was less pronounced than that of the penguins at Melbourne Zoo since there was an area that provided both physical and visual separation from visitors in the Wellington Zoo's penguin enclosure, minimising the intensity of close visitor contact (i.e., Zone 3; Chapter 4).

The differences in enclosure design may have also influenced some of the differences found in visitor attitudes and experience between the two Australian zoos (Chapter 6). Interestingly, visitors at both zoos were found to view the penguin enclosures in a similar manner, based on the visitor rating scores of the enclosures being similar (out of 10). Yet as previously mentioned, the enclosures at Melbourne and Taronga Zoo did differ dramatically in terms of their design. The different enclosure designs influenced the nature and intensity of visitor contact at each zoo, causing variation in penguin behaviour between the zoos. This variation in penguin behaviour may have also affected the differences found in visitor attitudes and experience between the two Australian zoos (Chapter 5 and 6). This is consistent with past research which shows animals that are more active, visible and engage in species-specific and less stereotypic behaviours, is positively associated with increased visitor viewing times and positive visitor attitudes and perceptions of zoos and zoo animals (Altman 1998; Sellinger and Ha 2005; Davey 2006a; Moss *et al.* 2010; Godinez *et al.* 2013; Godinez and Fernandez 2019). Therefore, it is

possible that the differences in enclosure design and its impact on visitor-penguin interactions may explain the differences in little penguin fear responses to visitors and the variation in visitor attitudes and experience across the study zoos found in the present thesis.

7.3.3 Previous experience

The varied magnitude of little penguin fear responses to visitors may have also been influenced by the little penguins' previous experiences. For example, little penguins at Taronga Zoo are exposed to daily close-up visitor encounters. These encounters involve a maximum of four visitors coming into the enclosure to feed the penguins with a keeper present. The regular exposure to visitors during close-up encounters may have provided more opportunities for the Taronga Zoo little penguins to habituate to visitors and associate them with something positive (i.e., food) in comparison to the penguins at Melbourne Zoo and Wellington Zoo. This may further explain the avoidance response of the penguins to unobstructed visitor contact at Taronga Zoo being the least pronounced out of the three study zoos. Research on wild penguins has shown that with regular exposure to and experience with human presence, some species of penguins can habituate to human disturbances (Fowler 1999; Ratz and Thompson 1999; Ellenberg *et al.* 2009; Villanueva *et al.* 2012). Also, studies on other zoo species have found positive effects of visitors on zoo animal behaviour, particularly when visitors are associated with food (Jones *et al.* 2016; Orban *et al.* 2016). However, considering that there was some behavioural change observed in the Taronga Zoo penguins, it is possible that the behavioural response towards visitors by the penguins during a close-up encounter may differ from their responses to visitors normally viewing them in the enclosure from the visitor viewing area. For example, the close-up encounters at Taronga Zoo involve 'controlled' visitor-penguin interactions where visitors are required to make no sudden movements or approaches to the penguins and are only allowed to feed the penguins when the penguins approached. In comparison, during normal exhibit viewing, visitor-penguin interactions are 'uncontrolled' where visitor interactions can be unpredictable and intense. This is consistent with Saiyed *et al.* (2019) who found that zoo-housed African penguins (*Spheniscus demersus*) showed no changes in affiliative and aggressive behaviours following close-up encounters with visitors in their enclosure. This may be because the interactions with visitors were controlled where visitors were instructed to sit quietly on a bench and only observe (Saiyed *et al.* 2019).

There were also differences in the little penguins' early life experience. The penguins studied at Melbourne and Taronga Zoo were all captive bred little penguins whereas the

little penguins at Wellington Zoo were all rescued from the wild. Research has shown that captive and wild bred animals can respond differently in zoos (Mathews *et al.* 2005; Conway 2011; Mason *et al.* 2013). For example, some first-generation captive bred animals may show adaptive developmental plasticity through the expression of beneficial phenotypic changes, such as a reduced stress response to captivity, compared to wild born individuals brought into captivity (Mason *et al.* 2013). Having this type of phenotypic change arguably suggests that some captive bred animals can thrive better in zoos compared to wild caught adult animals. However, some captive bred animals have also shown the evolutionary risks of developing in captive environments. For instance, some captive bred animals, over generations, have been found to have reduced behavioural flexibility, increased stereotypic behaviours and poor reproductivity compared to wild born captive conspecifics (Mason *et al.* 2013). This may be the result of the substantial differences between a captive environment and the wild such as human proximity, restricted space that may constrain species typical behaviours and altered climates in captive settings (Mathews *et al.* 2005; Conway 2011; Mason *et al.* 2013). Therefore, the varied little penguin fear responses to visitors across the three zoos in the present thesis may have been influenced by the penguins being born in the wild or in captivity. Further investigation on the effects of being wild or captive bred is required.

7.3.4 Genetics

In addition to the differences in enclosure design and previous experiences of the penguins, genetics may have also been an important influencing factor on the variation of little penguin fear responses to visitors between zoos. Recently, research has shown that there are differences in genetics between Australian and New Zealand little penguins in Wellington (Peucker *et al.* 2009; Grosser *et al.* 2015; Grosser *et al.* 2016; Grosser *et al.* 2017). It has been suggested that there are two congeneric taxa of little penguins; *Eudyptula novaehollandiae* being little penguins occurring in Australia and south east New Zealand (Otago) and *Eudyptula minor* being little penguins occurring in all other parts of New Zealand only (Peucker *et al.* 2009; Grosser *et al.* 2015; Grosser *et al.* 2016; Grosser *et al.* 2017). This genetic difference has been argued to be linked to differences in both morphology and behaviour between these distributions of little penguins (Grosser *et al.* 2015; Grosser *et al.* 2017). Little penguins found in Wellington (New Zealand) fall in the distribution that has been identified to genetically differ from Australian little penguins (Grosser *et al.* 2015). Furthermore, keepers at Wellington Zoo believed that the little penguins at their zoo were more pair and less colony driven and were described as being shy than Australian little penguins (S. Eyre and M. Forbes, *pers. comms.*, May 2018).

Therefore, while no formal genetic test was conducted, the potential genetic difference between the Australian zoos' and Wellington Zoo's little penguins may have also influenced the observed difference in little penguin fear responses to visitors across the zoos. However, there is a suggestion of some degree of hybrid ancestry in the Wellington little penguin population (Grosser *et al.* 2015). Future research is recommended to determine the extent in which the effects of visitors on *Eudyptula novaehollandiae* are reflected in *Eudyptula minor*, both in the wild and in captive settings.

7.3.5 Weather

In this thesis, there were several weather variables that were found to be useful covariates for improving the precision of the statistical analyses used to examine the effects of visitors on penguin behaviour and stress physiology. This indicates that weather strongly affected the behaviour and stress levels of little penguins. The behaviour of various wild penguin species has been shown to be affected by weather. For example, King and Emperor penguins increase sleeping and huddling behaviour at colder temperatures, respectively, Rockhopper penguins (*Eudyptes chrysocome*) and adult little penguins have reduced breeding success and survivability when there is severe rainfall and, Rockhopper, Adelie and Chinstrap penguins decrease activity, foraging success and time spent diving and foraging when there are increased wind speeds, particularly during storms that cause rough seas with high waves (Culik *et al.* 1989; Dewasmes *et al.* 2001; Gilbert *et al.* 2008; Demongin *et al.* 2010; Ganendran 2011; Dehnhard *et al.* 2013; Berlincourt and Arnould 2015; Ganendran *et al.* 2016; Saraux *et al.* 2016). Harsh inclement weather such as blizzards, extreme high and low temperatures, storms, and heavy rain have also been associated with increased corticosterone concentrations in bird species including penguins, (Wingfield *et al.* 1983; de Bruijn and Romero 2013; Thierry *et al.* 2013; Ozella *et al.* 2017; de Bruijn and Romero 2018; Scheun *et al.* 2020). Furthermore, recent research on zoo-housed lemurs have suggested weather and changes in time of day are stronger influences on zoo animal behaviour than visitors themselves (Goodenough *et al.* 2019). Therefore, weather factors such as extreme high or low temperatures, increased rainfall and strong winds may have influenced little penguin behaviour and physiology in the present thesis. Further evidence that may suggest possible weather effects on little penguins are the weather reports during the research studies in this thesis.

Weather reports during the study at Melbourne Zoo found that Melbourne (Victoria, Australia) experienced higher than average temperatures and average to below average rainfall (Bureau of Meteorology 2016; Bureau of Meteorology 2016; Bureau of Meteorology 2016). In comparison, Sydney (New South Wales, Australia) experienced a

well above average rainfall and record-warm nights during the Taronga Zoo study (Bureau of Meteorology 2017). Wellington (New Zealand) experienced unsettled weather patterns during the study at Wellington Zoo (Pezza *et al.* 2018a; Pezza *et al.* 2018b). Wellington in Autumn 2018 was wetter and windier than normal and experienced additional cases of flooding, heavy wind, and lightning strikes throughout the Autumn season (Pezza *et al.* 2018a). In Winter 2018, Wellington started off very wet and cold, had above average rainfall on the western coast and experienced a significant subtropical low in June (Pezza *et al.* 2018b). Thus, weather may have been an influencing factor on the varied little penguin behavioural response to visitors and lack of treatment effect on the physiological stress response of the penguins when visitor contact was regulated across the three zoos. Further research on the effects of weather on zoo-housed little penguin behaviour and physiology is required.

7.4 Challenges and Limitations

There were several methodological challenges encountered in the present thesis. As previously mentioned, each experiment at the three zoos had slightly different experimental designs and treatments that were imposed. This was primarily because of the different enclosure designs that affected the aspects of visitor contact that could be regulated. Also, the effects of zoo-housed little penguins on visitors were restricted to the examination of correlations to identify relationships between penguin behaviour and visitor attitudes and experience. There were also other logistical and practical challenges including the small sample sizes in terms of the number of zoos and animals examined, differences in husbandry and management practices across the zoos which may have introduced confounding variation and, some constraints by zoo management with temporary closures of exhibits or regulation of visitor contact. There were some concerns for the potential negative impact on visitor experience and possible interference with housing and husbandry routines from the closure of the penguin exhibits for too long. This latter challenge also had some impact on the number of days the treatments could be imposed for and the overall length of each study. Furthermore, direct correlations between visitor attitudes and their experience with their behaviour towards little penguins were not possible. This was due to the logistics and practicality of monitoring the behaviour of each visitor that was surveyed without compromising the recording and observation of the behaviour of visitors towards little penguins who were not surveyed. These methodological, logistical, and practical challenges are commonly faced in zoo-based research (Hosey 1997; Carlstead *et al.* 1999; Swaisgood and Shepherdson 2005; Davey 2006b; Swaisgood 2007; Sherwen and Hemsworth 2019). As a result, the

generalisability, and the external validity of the findings of this thesis to other zoos and aquariums as well as other species of penguins and zoo visitors is limited. The findings are mainly and immediately applicable to the animals and visitors studied at each of the zoos examined in this thesis.

Another limitation of this thesis is that the overall effect of visitors on the welfare of zoo-housed penguins was somewhat unclear. While fear responses were apparent in the treatments in which visitor contact was uncontrolled, penguin FGM concentrations which were collected at Melbourne and Wellington Zoo, were not found to be affected by the treatments imposed at these two zoos. It was not possible to measure FGM concentrations at Taronga Zoo because the penguins spent most of their time in the pool and thus, defecated primarily in the water. Some may argue that the lack of treatment effect on FGM concentrations suggests that zoo visitors may have minimal or no detrimental effect on the overall welfare of zoo-housed little penguins. However, as described in Chapter 1, the welfare of an animal refers to both the physical and psychological (affective) state within an animal (Broom 2008; Hemsworth *et al.* 2015; Broom 2016). Direct assessment of the welfare status of an animal involves the measurement of animal-based indicators including animal behaviour and physiology (Whay 2007; Whitham and Wielebnowski 2009; Koene 2013; Siegford 2013). Also, it is well established that monitoring of hormones as measures of stress in animals must be used in combination with other physiological and biological measures (e.g., immunoglobulins, endorphins, oxytocin, and heart rate) and/or other types of assessments (e.g., reproductive success, health, and behavioural monitoring), for accurate interpretation of hormonal data (Möstl and Palme 2002; Wielebnowski 2003; Shepherdson *et al.* 2004; Boissy *et al.* 2007; Whitham and Wielebnowski 2013). This is because an increase or decrease in glucocorticoid metabolites concentrations can indicate potential welfare compromise and so, interpretation of glucocorticoid data can often be ambiguous and challenging (Wielebnowski 2003; Cyr and Romero 2008; Whitham and Wielebnowski 2013; Otovic and Hutchinson 2015; Palme 2019). Therefore, despite little penguin FGM concentrations were not affected by the treatments in the present thesis, the behavioural changes observed in the penguins indicates there may still be a welfare concern. Visitors were found to be potentially fear-provoking for little penguins, indicated by the substantial increase in avoidance behaviours and reductions in highly motivated behaviours such as swimming, and comfort behaviours such as preening. This suggests a negative visitor effect. If this negative visitor effect is not managed, it may result in short- and long-term adverse welfare impacts on the penguins. As discussed in Chapters 2, 3 and 4, there are several possible explanations for the lack of treatment effects

on FGM concentrations in each of the studies. The opportunity for the penguins to have choice and control over their interactions with visitors, as a result of the design of the enclosures, may have ameliorated the need for the substantial activation of the HPA axis arising from uncontrolled visitor contact. Also, treatment periods of greater than two days may be required to detect a measurable change in FGM concentrations, especially when the treatments imposed were aimed at reducing FGM concentrations by removing a long-term stressor like visitors. However, due to the logistical and practical constraints of each of the studies in this thesis, treatment periods of greater than 2-days were not feasible. Therefore, the observed effects on little penguin behaviour and stress physiology in this thesis are reflective of short-term welfare implications only.

It was also not possible to examine the effects of visitors at the individual penguin level which is another limitation of the present thesis. This was the result of technological challenges with the cameras used to record penguin behaviour which could not easily discern the identification bands or physical differences of the little penguins. Zoos are increasingly interested and shifting towards assessing animal welfare at the individual level and not just at the group level. This is because an animal's welfare is greatly dependent on species traits and individual animal factors such as genetics, temperament, and previous experience and how these factors interact with environmental factors such as social grouping, enclosure design and the presence of visitors (Watters and Powell 2012; Hosey *et al.* 2013; Sherwen and Hemsworth 2019; Learmonth 2020). By considering the individual rather than the group allows for individual needs to be addressed and for overall better individual management (Polgar *et al.* 2017; Sherwen and Hemsworth 2019; Boyle *et al.* 2020; Learmonth 2020). For example, Polgar *et al.* (2017) found squirrel monkeys were not affected by visitors at the group level but found differences at the individual level in terms of time spent at the viewing window; for small and large groups of visitors, individual percentages ranged from 0-37% and 0-88% of time spent at the window, respectively. Also, Garnett's greater galagos (*Otolemur garnettii*) have been shown to change their behaviour depending on the level of human proximity (i.e., close, medium, far), but the behaviours that changed (e.g., interactive, rest, stereotypic, and out of sight) varied between individuals (Boyle *et al.* 2020). Different behavioural responses to environmental factors have also been found to be associated with personality differences of individual animals. (Dingemanse *et al.* 2010; Polgar *et al.* 2017). Furthermore, Hall *et al.* (2018) found that there were significant within and between species variation in terms of curiosity to novel objects for four different zoo species, little penguins, ringtail lemurs, Indian star tortoises and red kangaroos. Results from this study highlighted the importance of looking at individuals. However, despite evidence

of individual variation, Hall *et al.* (2018) found that little penguins' responses to novelty had little variation between individuals compared to the other species studied. This could suggest that in the context of the effect of visitors, little penguins may show little variation between individuals in response to visitors. Therefore, examining at the group level in the present thesis may not have been as limiting as expected. However, further research is needed to investigate individual little penguin responses to visitors to clarify whether this may be true.

The challenges and limitations encountered when assessing the attitudes and experience of visitors in the present thesis have been described in detail in Chapters 5 and 6. Nevertheless, the primary limitation of the visitor attitude and experience results is the limited ability to generalise the results to other zoos. This is because the attitudes and experience of visitors assessed in this thesis may not be representative of the population of visitors that visit Melbourne and Taronga Zoo or even zoos in general as a result of some biases. For instance, visitors that completed the questionnaire were biased toward people living in Australia, pet owners and females which are common biases found in questionnaire data (Driscoll 1992; Kendall *et al.* 2006). Furthermore, it is well established that attitudes toward animals can vary as a result of demographic, socioeconomic and cultural factors as well as past experiences with animals (Bjerke *et al.* 2003; Taylor and Signal 2005; Prokop and Tunnicliffe 2010; Clucas and Marzluff 2012). Additionally, the zoo experience, which may include the viewing of animal exhibits, close-up animal experiences, presentations, shows, conservation, and education programs, have been shown to influence the attitudes and experience of visitors (Falk *et al.* 2007; Pearson *et al.* 2014; Roe *et al.* 2014; Moss *et al.* 2017; Mann *et al.* 2018; Godinez and Fernandez 2019; Mellish *et al.* 2019; Chiew *et al.* 2021b). Therefore, capturing the wide variation in visitor attitudes and experience, from different demographic backgrounds within the present thesis was not possible and is restricted to the visitors and zoos examined in this thesis. Another limitation of the visitor attitude and experience results, as previously mentioned, was the fact that direct correlations between the attitudes and experience of visitors surveyed with their behaviour towards little penguins were not possible. Thus, it is unclear whether the positive attitudes and experience of visitors found in this thesis influenced the way they behaved towards little penguins (Chapter 5 and 6).

7.5 Implications for zoos and future research

Despite the limitations of this thesis, the findings have clearly demonstrated the significant benefit in implementing an experimental approach to examine the zoo visitor-animal relationship from both the animal and visitor aspects. This can be extrapolated to

zoos and aquaria worldwide and further increase our understanding of zoo visitor-animal interactions. Results of this thesis have also established that there are some common characteristics of visitor contact that affect little penguin fear responses towards visitors. These common characteristics include close visitor contact or the close viewing proximity of visitors, in particular close human contact from above. While close viewing proximity may be beneficial for the viewing experience of visitors, these characteristics of visitor contact may increase the likelihood of potentially fear-provoking and intense visitor behaviours occurring (e.g., banging on enclosure features, close and looming behaviour, and sudden movement). This has also been found in studies on other species of zoo-housed penguins as well as wild penguins (Klomp *et al.* 1991; Wienecke *et al.* 1995; Nimon 1997; Giese 1998; Weerheim *et al.* 2003; Holmes *et al.* 2005; Giling *et al.* 2008; Shaughnessy and Briggs 2009; Schuster 2010; Ozella *et al.* 2014). Thus, having features of a penguin enclosure that allows the close viewing proximity of visitors, such as visitors looming over the pool, may be ineffective in improving visitor experience, since this species of penguins is likely to avoid these types of viewing areas when visitors are present. This thesis identified that close visitor contact can be regulated by positioning visitors further away from the enclosure boundary or by reducing the perceived close proximity of visitors in little penguins. Increased separation between visitors and little penguins, whether with the use of a physical barrier to push visitors back from the enclosure or re-designing enclosures in a way that allows for this, can reduce little penguin fear responses towards visitors (Chapter 2 and 4). Zoos can also consider reducing the perception of the close viewing proximity of visitors by positioning visitors below penguins, by providing areas for penguins that are visually hidden from visitors or by using one-way viewing windows (Chapter 3). These practical measures were found to have no detrimental effect on visitor attitudes and experience (Chapter 5). Therefore, the practical measures examined in this thesis, can ultimately result in improvements in penguin welfare without compromising visitor experience. Zoos, aquaria, and other ecotourism establishments worldwide, should consider and use the results from this thesis to better manage visitor-penguin interactions in captive and wild settings, especially since avoidance responses to visitors are apparent in a range of penguin species.

Results from this thesis have also identified a number of areas for future research to build upon. Firstly, applying the methodological approach used in this thesis whereby both zoo animal and visitor implications of the relationship are examined, would be valuable to extend to other species and zoos. Through this approach and replication, a better understanding of how visitors and zoo animals influence one another will help improve

the management of visitor-animal interactions, increase the external validity of this thesis' results, and allow generalisations beyond little penguins and the visitors examined in this thesis to be drawn. Secondly, evaluation of the effectiveness of other practical measures such as one-way viewing windows would be beneficial as many zoos and aquaria that house penguins utilise conventional glass viewing windows. Thirdly, as a result of a number of weather variables identified as significant covariates, the effects of weather on zoo-housed little penguin behaviour and physiology requires further examination. Fourthly, examination of how visitor attitudes and their experience influence their behaviour, especially the attitudes of visitors towards the way they behave towards zoo animals is vital. Human attitudes are drivers of behaviour and since some behaviours can be perceived as threatening by animals, it is evident human attitudes and behaviour towards animals have implications on animal welfare (Ajzen 1991; Fishbein and Ajzen 2010; Hemsworth *et al.* 2018). Therefore, by understanding the attitudes that may influence human behaviour towards animals, behaviour change interventions may be developed to continuously improve the lives of animals not only in zoos but across the different animal industries. Fifthly, investigation of the effects of the specific enclosure design characteristics that may be influencing the positive, neutral, and negative visitor attitudes identified in this thesis is recommended.

7.6 Conclusions

This is the first thesis that has examined the effects of regulating the interactions between visitors and little penguins, on the welfare of little penguin and the behaviour, attitudes, and experience of visitors. Results of this thesis indicate that the close viewing proximity of visitors is a common characteristic of visitor contact that zoo-housed little penguins may find fear-provoking. However, the magnitude of little penguin fear responses to visitors varies across zoos as a result of potential influencing factors including enclosure design, previous experience, genetics, and weather. Nevertheless, close visitor viewing proximity can be regulated by positioning visitors further away from the enclosure boundary or by reducing the perceived close proximity of visitors for little penguins. Results from this thesis also indicate that visitor attitudes towards little penguins, penguin welfare, the penguin enclosure and exhibit manipulations as well as visitor experience were overall positive. These positive attitudes of visitors were found to be correlated with penguin behaviour as well as how visitors rated the welfare of the penguins, the enclosure, and their experience at the penguin enclosure. This suggests that penguins can influence the attitudes and experience of visitors, which may have subsequent effects on visitor behaviour towards penguins. Furthermore, no detrimental effect of regulating visitor-penguin interactions using exhibit manipulations such as physical and visual barriers were found on visitor attitudes and experience. Therefore, I conclude that this thesis expands our knowledge on the zoo visitor-penguin relationship, providing insight on the effects of regulating visitor-penguin interactions on both the animals and the visitors and has identified some practical measures that zoos can utilise to improve the welfare of zoo-housed little penguins and visitor experience.

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Appendix 1: Melbourne Zoo questionnaire

Visitor attitude and experience survey

*You are invited to participate in a research project investigating the effects of visitors on little penguins (*Eudyptula minor*). The study is being conducted by Samantha Chiew (PhD student), Professor Grahame Coleman (University of Melbourne) and Professor Paul Hemsworth (University of Melbourne).*

Research on this topic is important to identify opportunities to enhance zoo penguin welfare and visitor experience.

As an important part of the zoo community and environment, your experience, interests, and concerns are important and therefore I would greatly appreciate any insight you can offer. The questionnaire is completely anonymous and has been approved by the Human Research Ethics Committee (University of Melbourne - Ethics Application 1545739.1). The questionnaire refers to your perceptions of little penguins, their enclosure, exhibit manipulations and visitor experience.

Section 1: Demographics

Type of visitor (please tick box)

Zoo member ☐ Non-zoo member ☐

Are you?

1. Male
2. Female

Do you, or have previously, owned a pet (Y /N)? _____

What is your age?

1. 18-25
2. 26-35
3. 36-45
4. 46-55
5. 55+

What is your highest level of education?

1. No formal schooling
2. Primary school
3. Secondary School
4. Technical or further education institution (including TAFE College)
5. University or other higher education institution
6. Other educational institution (write) _____

If you're an Australia resident, what is your current residential address postcode? _____

If you're an overseas visitor, what country are you from? _____

Section 2: Penguins

Q1. What date did you visit the penguins? _____

Q2. Do you think little penguins are:

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Aggressive	1	2	3	4	5
Interesting	1	2	3	4	5
Friendly	1	2	3	4	5
Intelligent	1	2	3	4	5
Playful	1	2	3	4	5
Timid	1	2	3	4	5
Social	1	2	3	4	5
Cute	1	2	3	4	5
Curious	1	2	3	4	5
Interactive	1	2	3	4	5
Proactive	1	2	3	4	5

Q3. On a scale from 1-10 how would you rate the welfare of the little penguins? (1=very poor to 10=excellent).

1	2	3	4	5	6	7	8	9	10

Q4. Do you think the penguins are:

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Happy	1	2	3	4	5
Healthy	1	2	3	4	5
Alert	1	2	3	4	5

Anxious	1	2	3	4	5
Bored	1	2	3	4	5
Calm	1	2	3	4	5
Frustrated	1	2	3	4	5
Frightened	1	2	3	4	5
Stressed	1	2	3	4	5
Subdued	1	2	3	4	5
Expressing natural behaviours	1	2	3	4	5
Under-stimulated	1	2	3	4	5

Q5. Do you think penguins:

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Find visitors interesting?	1	2	3	4	5
Find visitors entertaining?	1	2	3	4	5
Find visitors fear-provoking?	1	2	3	4	5
Find visitors novel?	1	2	3	4	5
Are unbothered by visitors?	1	2	3	4	5

Section 3: Enclosure Design

Q6. On a scale from 1-10 how would you rate the little penguin enclosure? (1=very poor to 10=excellent).

1	2	3	4	5	6	7	8	9	10

Q7. Do you think the penguin enclosure is:

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Well maintained	1	2	3	4	5
Natural looking	1	2	3	4	5

Spacious	1	2	3	4	5
Small	1	2	3	4	5
Restrictive	1	2	3	4	5
Bland	1	2	3	4	5
Interesting to look at	1	2	3	4	5
Meeting the needs of penguins	1	2	3	4	5

Section 4: Visitor Experience

Q8. On a scale from 1-10, how would you rate your experience at the penguin enclosure? (1=terrible to 10=excellent).

1	2	3	4	5	6	7	8	9	10

Q9. Please circle the number you feel is most appropriate for each statement listed:

Statement	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
It was exciting to see the little penguins.	1	2	3	4	5
It was entertaining to watch the little penguins.	1	2	3	4	5
The exhibit was engaging.	1	2	3	4	5
I like being close to the penguins.	1	2	3	4	5
I like seeing the penguins active and engaging in lots of behaviours.	1	2	3	4	5
I do not like when the penguins hide and are inactive.	1	2	3	4	5
I learnt about penguin behaviour when I was at the penguin exhibit.	1	2	3	4	5
I learnt about a penguin's natural lifestyle.	1	2	3	4	5
I learnt about conservation issues related to penguins.	1	2	3	4	5
I wish there was more information about the penguins at the exhibit.	1	2	3	4	5
I felt a sense of connection to the little penguins.	1	2	3	4	5
If I could, I would like to do something to help care for little penguins in captivity and in the wild.	1	2	3	4	5

Section 5: Enclosure Manipulations

Q10. Please circle the number you feel is most appropriate for each statement listed:

Statement	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Having one-way visual barriers where penguins cannot see visitors, but visitors can see penguins improves penguin welfare.	1	2	3	4	5
Having one-way visual barriers where penguins cannot see visitors, but visitors can see penguins improves visitor experience.	1	2	3	4	5
Having physical barriers that reduce the proximity between visitors and penguins improves penguin welfare.	1	2	3	4	5
Having physical barriers that reduce the proximity between visitors and penguins improves visitor experience.	1	2	3	4	5

Q11. Are there any other comments you would like to make about the penguins or their enclosure? If yes, please comment below:

Thank you for taking time to complete this survey.

Appendix 2: Taronga Zoo questionnaire

Visitor attitude and experience survey

You are invited to participate in a research project investigating the effects of visitors on little penguins (Eudyptula minor). The study is being conducted by Samantha Chiew (PhD student), Professor Grahame Coleman (University of Melbourne) and Professor Paul Hemsworth (University of Melbourne).

Research on this topic is important to identify opportunities to enhance zoo penguin welfare and visitor experience.

As an important part of the zoo community and environment, your experience, interests, and concerns are important and therefore I would greatly appreciate any insight you can offer. The questionnaire is completely anonymous and has been approved by the Human Research Ethics Committee (University of Melbourne - Ethics Application 1545739.3). The questionnaire refers to your perceptions of little penguins, their enclosure, exhibit manipulations and visitor experience.

Section 1: Demographics

Type of visitor (please tick box)

Zoo member ☐ Non-zoo member ☐

Are you?

1. Male
2. Female

Do you, or have previously, owned a pet (Y /N)? _____

What is your age?

1. 18-25
2. 26-35
3. 36-45
4. 46-55
5. 55+

What is your highest level of education?

1. No formal schooling
2. Primary school
3. Secondary School
4. Technical or further education institution (including TAFE College)
5. University or other higher education institution
6. Other (write) _____

If you're an Australian resident, what is your current residential address postcode? _____

If you're an overseas visitor, what country are you from? _____

Section 2: Penguins

What date did you visit the penguins (DD/MM/YY)? _____

Q1a. Did you participate in the penguin encounter (Y /N)? _____

Q1b. If no, did you see the penguin encounter (Y/N)? _____

Q1c. If yes, approximately how long did you watch the encounter for? _____

Q2. Do you think little penguins are:

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Aggressive	1	2	3	4	5
Exciting	1	2	3	4	5
Interesting	1	2	3	4	5
Friendly	1	2	3	4	5
Intelligent	1	2	3	4	5
Playful	1	2	3	4	5
Timid	1	2	3	4	5
Social	1	2	3	4	5
Cute	1	2	3	4	5

Q3. On a scale from 1-10, how would you rate the welfare of the little penguins at Taronga Zoo? (1=very poor to 10=excellent).

1	2	3	4	5	6	7	8	9	10

Q4. Do you think the penguins at Taronga Zoo are:

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Happy	1	2	3	4	5
Healthy	1	2	3	4	5
Alert	1	2	3	4	5
Anxious	1	2	3	4	5

Bored	1	2	3	4	5
Calm	1	2	3	4	5
Frustrated	1	2	3	4	5
Frightened	1	2	3	4	5
Stressed	1	2	3	4	5
Subdued	1	2	3	4	5
Expressing natural behaviours	1	2	3	4	5

Q5. Do you think the penguins at Taronga Zoo:

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Find visitors interesting?	1	2	3	4	5
Find visitors entertaining?	1	2	3	4	5
Find visitors fear-provoking?	1	2	3	4	5
Find visitors novel?	1	2	3	4	5
Are unbothered by visitors?	1	2	3	4	5

Section 3: Enclosure design

Q6. Overall, on a scale from 1-10, how would you rate the little penguin enclosure at Taronga Zoo? (1=very poor to 10=excellent).

1	2	3	4	5	6	7	8	9	10

Q7. Do you think the penguin enclosure is:

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Well maintained	1	2	3	4	5
Natural looking	1	2	3	4	5
Spacious	1	2	3	4	5
Small	1	2	3	4	5

Restrictive	1	2	3	4	5
Bland	1	2	3	4	5
Interesting to look at	1	2	3	4	5
Meeting the needs of penguins	1	2	3	4	5

Section 4: Visitor experience

Q8. On a scale from 1-10, how would you rate your experience at the penguin enclosure? (1=terrible to 10=excellent).

1	2	3	4	5	6	7	8	9	10

Q9. Please circle the number you feel is most appropriate for each statement listed:

Statement	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
It was exciting to see the little penguins.	1	2	3	4	5
It was entertaining to watch the little penguins.	1	2	3	4	5
The exhibit was engaging.	1	2	3	4	5
I like being close to the penguins.	1	2	3	4	5
I like seeing the penguins active and engaging in lots of behaviours.	1	2	3	4	5
I do not like when the penguins hide and are inactive.	1	2	3	4	5
I learnt about penguin behaviour when I was at the penguin exhibit.	1	2	3	4	5
I learnt about a penguin's natural lifestyle.	1	2	3	4	5
I learnt about conservation issues related to penguins.	1	2	3	4	5
I wish there was more information about the penguins at the exhibit.	1	2	3	4	5
I felt a sense of connection to the little penguins.	1	2	3	4	5
I would like to do something to help care for little penguins in captivity.	1	2	3	4	5
I would like to do something to help care for little penguins in the wild.	1	2	3	4	5

Section 5: Enclosure manipulations

Q10. Please circle the number you feel is most appropriate for each statement listed:

Statement	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Having one-way visual barriers where penguins cannot see visitors, but visitors can see penguins improves penguin welfare.	1	2	3	4	5
Having one-way visual barriers where penguins cannot see visitors, but visitors can see penguins improves visitors' experience.	1	2	3	4	5
Having physical barriers that prevent visitors from touching the glass, improves penguin welfare.	1	2	3	4	5
Having physical barriers that prevent visitors from touching the glass, improves visitors' experience.	1	2	3	4	5

Q11. Are there any other comments you would like to make about the penguins or their enclosure? If yes, please comment below:

Thank you for taking time to complete this survey.