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Article

The Impacts of Evening Events in Zoos: A Christmas Event at Knowsley Safari

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Abstract: It is important to examine the animal welfare implications of all aspects of zoo operations, including out-of-hours public events. Research to date has indicated variable responses across species and event types. The current research aimed to understand and quantify the impact of a Christmas lights event. Four species: Rothschild giraffe (*Giraffa camelopardalis rothschildi*; $n = 2$) in one exhibit and capybara (*Hydrochoerus hydrochaeris*; $n = 4$), lowland tapir (*Tapirus terrestris*; $n = 3$) and vicuña (*Lama vicugna*; $n = 5$) in a mixed species exhibit were observed. Data were collected from 16:00–20:00 between 28 October 2021 and 11 January 2022. The event ran from mid-November to the end of December 2021. Five-minute behavioural observations were undertaken once per hour using instantaneous scan sampling with a one-minute inter-scan interval. A further six days of 12 h observations were conducted to enable a more detailed investigation post-event. Data collected were compared on non-event and event days using Mann–Whitney U tests (event vs. non-event) and Kruskal–Wallis tests (pre-event, event, post-event periods). Kruskal–Wallis tests and one-way ANOVAs were undertaken to compare behaviours during three time periods (12:00–16:00, 16:00–20:00, 20:00–00:00) over 12 h. Mixed behavioural responses were seen across the study species. Capybara spent more time in their house from 16:00–20:00 on event nights compared to non-event nights ($p < 0.001$) and tapir only engaged in vigilant behaviour from 16:00–20:00 when the event was held, ($p = 0.044$). There were no differences in frequency of behaviour between pre-event, event, and post-event observation periods, with the exception of capybara, who spent more time OOS in the pre-event period than during ($p < 0.001$) or after the event ($p < 0.001$). The results of the project, undertaken as part of an evidence-based management programme, highlighted that the event did not have any overtly negative impacts on the individuals studied. Except for the giraffe, all individuals had free access to inside and outside environments, and it is believed this choice enabled animals to be active in managing their response to the event. It is recommended that future work observe animals over 24 h to understand whether events lead to behavioural changes the day after events or if animals reverted to normal activity once the event ended.

Keywords: animal behaviour; Christmas lights; zoo animal welfare; evidence-based management

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1. Introduction

The relationship between zoo animals and visitors is complex; visitors can be both a source of enrichment and stimulation for animals. Animal responses to visitors are variable, and even within species, individual responses to zoo visitors are observed [1]. Extending visitor hours within zoos is popular worldwide; many facilities host concerts and other events outside of standard zoo visiting hours. Increased exposure to visitors has the potential to disrupt animal activity patterns [2]. During these events, animals may be exposed to high visitor numbers, altered routines and increased periods of artificial light and loud noise, which have been identified as potential 'stressors' [3,4]. Events may therefore have ramifications for animal welfare. Zoos must balance animal welfare with increased footfall and income when holding these events [5,6]. Understanding the impact of these potential stressors is vital in developing an effective zoo management strategy [7], which is required to maintain a high standard of animal welfare.

While there is a plethora of historic research which aims to understand the impact of visitors in zoos on animal welfare, it is only relatively recently that attention has turned to understanding the effects of out-of-hours events on animal behaviour and welfare. The zoo environment is variable [8]; however, evening events provide a unique setting where animals are exposed to additional environmental stimuli outside the conditions they usually experience. The range of additional concurrent environmental stimuli makes the impact of evening events challenging to predict.

Previous research has focused predominantly on sound (including music and fireworks) in addition to light (e.g., [6,9–11]). These studies highlight mixed responses of animals to evening events in zoos, with some animals changing behaviour and using enclosures differently, whilst others are unaffected. Recent research has highlighted 'risk' factors for species that may be most likely to be impacted behaviourally, including terrestrial, herbivorous/omnivorous and diurnal species from closed habitats [12]. Behavioural assessments have been more widely undertaken than any other measure, presumably due to the ease of undertaking these non-invasive assessments and the opportunities for facilities to undertake this without specialised equipment or significant financial investments. When conducted in person or via camera feeds, behavioural observations have the added benefit of enabling facilities to find out 'instantly' the impacts of evening events and act accordingly to support good animal welfare. However, assessment of physiological measures, principally analysis of faecal glucocorticoid metabolites (FGMs), has indicated that animals are less affected by the presence of visitors than their behaviour signifies [13–15], which may also explain the range of behaviour changes during evening events, with animals adapting to reduce the impacts of stressors related to evening events.

Several behavioural changes have been observed within primate species. Macaques (*Macaca fuscata*) exposed to increased noise displayed changes in affective state indicative of anxiety [16]. Brown spider monkeys (*Ateles hybridus*) increased vigilance on event nights, with some individuals also showing reductions in affiliative behaviour and increases in locomotion and feeding behaviour [17]. Spider monkeys housed near a haunted house event, where actors were scaring visitors (leading to scream responses from visitors), spent longer outside, were generally more active and showed startle responses [18]. Drills (*Mandrillus leucophaeus)* increased vigilance and reduced feeding the day after some evening events (Christmas parties and zoo-wide themed evenings), although this was not consistently seen across different events [19]. Gorillas (*Gorilla gorilla*) increased abnormal behaviours (regurgitation and reingestion) and reduced resting behaviour during events, although there were no increases in FGMs [2,20].

Behaviour changes have also been seen in non-primate species. Fiordland penguins (*Eudyptes pachyrhynchus*) and collared peccaries (*Pecari tajacu*) exposed to music during an evening event used their enclosures differently. Penguins spent more time swimming, and peccaries increased their time in nest boxes and out of sight [21]. Alpacas (*Vicugna pacos)* were more active during a zoo concert and spent less time resting when sound pressure levels were highest [6]. Tigers (*Panthera tigris sondaica*) increased resting behaviour and reduced feeding, locomotion and play during event evenings. Furthermore, stretching, spraying, rubbing, flehmen and glass banging increased when events were on at the zoo. Tigers also increased their use of areas more distant from visitors during event evenings [22]. Changes are not consistent over large carnivore species. In one study, Asiatic lions (*Panthera leo persica*) displayed no change in activity or enclosure use during evening summertime parties [22]. Some species that would typically be expected to respond negatively to events according to their life history [23] showed no behavioural changes during a zoo concert, e.g., reindeer (*Rangifer tarandus*) and guanaco (*Lama guanicoe*) [6]. Classical music also did not impact llamas (*Llama glama*), mara (*Dolichotis patagonum*) and bison (*Bison bison*), although the same individuals were more nervous and attentive when loud explosions were heard in a fireworks display [10].

For some species, behavioural changes have been linked with other factors, and although physiological changes occurred, this was no different to their response to other stressors within their environment. Indian hornbills (*Buceros bicornis*) displayed altered affiliative behaviour and proximity to conspecifics during and after event periods. Ultimately these were attributed to the onset of the breeding season rather than the event itself [11]. A fivefold increase in FGMs in coyotes (*Canis latrans*) following a two-day national holiday with fireworks was the same as their response to a newly installed fan [9]. In Hawaiian honeycreepers (*Drepanis coccinea*), elevated FGMs the day after evening concerts at Honolulu Zoo were the same level as when this was assessed following exposure to loud machinery or social stimuli [23].

This brief overview of literature published to date indicates that there is potential for evening events within zoological collections to impact the welfare of captive animals negatively. It has been suggested that terrestrial, herbivorous/omnivorous, and diurnal species from closed habitats are most likely to be affected by zoo visitors. Thus species observed in this study could be particularly sensitive to the public [12], particularly during periods when the public is within zoos outside of 'normal' opening hours.

The need to increase our understanding of the effect of evening events on animal behaviour and welfare has been advocated [11,19,24]. Indeed, it is pivotal in ensuring good welfare for zoo species. As part of the evidence-based management programme at Knowsley Safari, research was undertaken to document animal behaviour during the annual Christmas lights event, "Enchanted", to ensure that any event impacts were accurately documented and to enable the execution of appropriate mitigation strategies if required. During this event, animals were exposed to music, lights and visitors in the foot safari area of the park later into the evening than they would routinely experience.

The current study aimed to examine the effect of a Christmas evening event at Knowsley Safari on the behaviour of a selection of species housed in the foot safari area of the zoo, the focus area of the event. To do this, we pose the following research questions:

(1) Did the study species display differences in behaviour during event hours (16:00–20:00) on days when the event was running compared to days when the event was not running?
(2) Did the study species display differences in behaviour within a 12 h period (12:00–00:00) on a selection of days throughout the study period?
(3) Did the study species display differences in behaviour within that 12 h period on days when the event was running compared to days when the event was not running?

2. Materials and Methods

2.1. Study Site and Subjects

Subjects were housed in the foot safari section of Knowsley Safari. Subjects were Rothschild giraffe (*Giraffa camelopardalis rothschildi*), (n = 2, 2 × male) in one exhibit and capybara (*Hydrochoerus hydrochaeris*), (n = 4, 2 × male and 2 × female), lowland tapir (*Tapirus terrestris*), (n = 3, 3 × male) and vicuña (*Lama vicugna*) (n = 5, 5 × male) in a mixed species exhibit. The event and light trail were in the vicinity of all the species enclosures included in this study (Figure 1). Giraffes were locked in their house at approximately 15:30 daily; this is standard winter management practice as giraffes are not cold tolerant [25]. The giraffe had free choice access to their house and paddock during daylight hours when temperatures were above 5 °C. Below this temperature they were housed inside. All other species had access to their house and their paddock at all times.

Figure 1. Map of the event space at Knowsley Safari. Areas featured in the present study are shaded and the light trail is marked, including recommended direction of travel. Visitors have access to the light trail and the blue area with visitor facilities. CCTV cameras were located in the houses of each species, and did not cover either paddock.

2.2. Data Collection

Behavioural observations were conducted using pre-recorded CCTV video footage. Footage was gathered from pre-existing cameras (Hikvision DS-2CD2347G2-LU, Hangzhou, sourced United Kingdom), two in the giraffe house and four in the house of the mixed species exhibit. Using remote video monitoring enabled the opportunity to collect data when no people were in the zoo and without influencing animal behaviour through observer presence.

The Christmas lights event (henceforth known as the event) ran from mid-November to the end of December 2021. Behaviour was recorded from 16:00–20:00 over 21 days from 28 October 2021 to 11 January 2022. The breakdown of dates in relation to event status and hours observed can be found in Table 1. One five-minute observation period was undertaken per hour of observations, with a random number generator used to identify the start time within the hour. Behavioural observations were conducted using instantaneous scan sampling (with a one-minute inter-scan interval) over the five-minute sampling period with a pre-defined ethogram (Table 2). This approach was taken to capture a snapshot of behaviour, a method advocated as an easy means of reliably capturing data on animal behaviour in a relatively short time that can be used readily within zoological collections [26].

Table 1. The dates and time of behavioural observations throughout the study period.

Pre Event		Event		Post Event	
Date	**Time**	**Date**	**Time**	**Date**	**Time**
28 October 2021	16:00–20:00	11 December 2021	24 h	5 January 2022	24 h
29 October 2021	16:00–20:00	12 December 2021	16:00–20:00	6 January 2022	16:00–20:00
30 October 2021	16:00–20:00	13 December 2021	16:00–20:00	7 January 2022	16:00–20:00
31 October 2021	24 h	14 December 2021	16:00–20:00	8 January 2022	24 h
16 November 2021	16:00–20:00	15 December 2021	16:00–20:00	9 January 2022	16:00–20:00
18 November 2021	16:00–20:00	16 December 2021	16:00–20:00	10 January 2022	16:00–20:00
19 November 2021	24 h	17 December 2021	24 h	11 January 2022	16:00–20:00

Table 2. Ethogram of behaviours (Adapted from [6]).

Behaviour	Description
Locomotion	Actively moving around enclosure at any speed
Resting	Inactive and stationary; eyes may be closed or open. May be standing, sitting, or lying down
Vigilant	Stationary paying attention to the environment or scanning/checking environment
Ruminating (giraffe only)	Repeatedly chewing the cud
Eating	Actively eating, drinking, foraging, grazing, or browsing
Abnormal Repetitive	Pacing (repetitive, fixed pattern), repeated licking, head rolling, excessive locomotion (restlessness/agitated at any gait)
Locomotion	Actively moving around enclosure at any speed
Resting	Inactive and stationary; eyes may be closed or open. May be standing, sitting, or lying down

There were 56 observation periods on nights when the event was not running (non-event nights) and 28 on days when the event was running (event nights). All behaviours occurring at each scan point were recorded, but were not attributed to uniquely identified individuals. Data were pooled to calculate the total number of behaviour frequencies per scan point for the whole group (i.e., the maximum frequency of behaviours per sampling period was five times the number of individuals in the group).

2.3. Data Analysis

All data were assessed for normality using a Shapiro–Wilk test. The majority of the data were not normally distributed ($p < 0.05$). A Mann–Whitney U test was used to investigate the differences between frequency of behaviour on event nights and non-event nights during the 16:00–20:00 data observation period and between event nights and non-event nights for the 12:00–16:00 and 20:00–00:00 observation periods. With the exception for rumination in the giraffe, a Kruskal–Wallis test was used to determine whether there were differences in behaviour frequency between the three time periods within the 12 h observation period (i.e., 12:00–16:00, 16:00–20:00, 20:00–00:00). A one-way ANOVA was used to assess rumination behaviour in giraffes during this time period owing to this data being normally distributed ($p > 0.05$). Bonferroni corrected post hoc tests were used where appropriate to determine where the differences lay between these time periods. Kruskal–Wallis tests with Bonferroni corrected post hoc tests where appropriate were used to determine whether there was an impact of data collection period on behaviour (before the event period, during the event period, after the event period).

Out of sight was not analysed for the giraffe from 16:00 as they were locked into the interior aspect of their enclosure.

3. Results

3.1. Capybara

Capybaras spent most of the time in sight between 16:00 and 20:00 resting, followed by eating and locomotion, regardless of whether it was an event or non-event night. Vigilance and ARBs were never observed (Figure 2). There was no difference in the average number of occurrences of locomotion (U = 675.000, Z = −1.646, p = 0.100), resting (U = 685.000, Z = −0.957, p = 0.338) or eating (U = 704.000, Z = −0.818, p = 0.413) between event nights and non-event nights. Average number of occurrences of capybara being out of sight significantly decreased during event nights compared to non-event nights (U = 429.000, Z = −3.431, p < 0.001). There was a significant difference in OOS behaviour across the three data collection points (before, during, and after the event; H = 35.063, df = 2, p < 0.001). Post hoc tests indicated that period of time spent OOS of the observer (i.e., within the outside paddock) was higher before the event season than during the event season (U = 34.464, p < 0.001) or after the event season (U = 30.893, p < 0.001). There were no other significant differences in behaviour across the three data collection points.

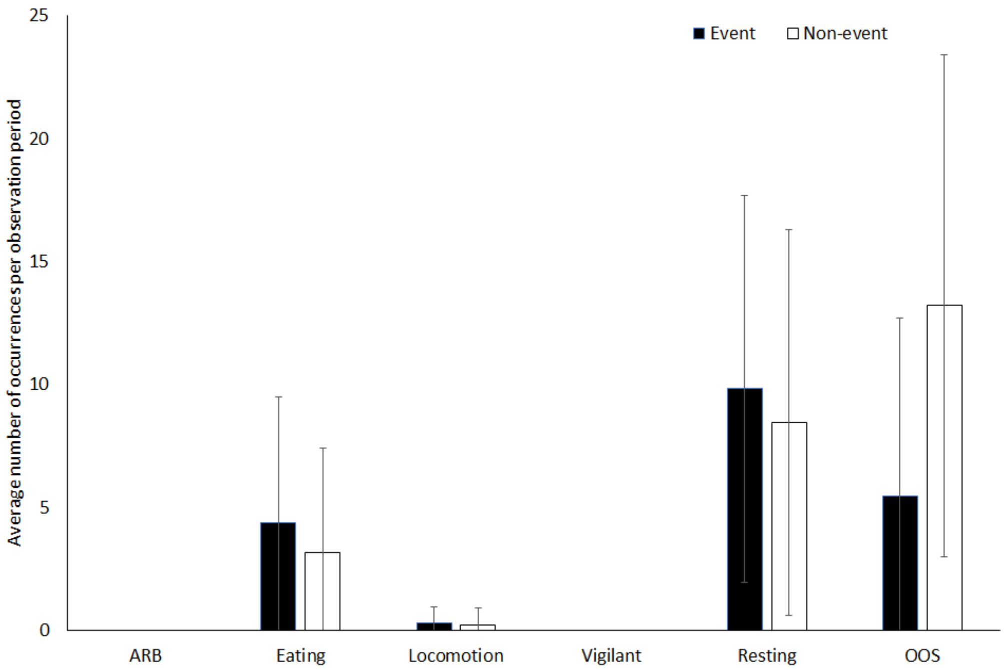

Figure 2. Activity budget data from 16:00 to 20:00 for four capybara (average number of occurrences of each behaviour within the group per observation period ± standard deviation) on event nights and non-event nights at Knowsley Safari. ARB: abnormal repetitive behaviour, OOS: out of sight of the observer.

Across the 12 h period, there was no difference in the average number of occurrences of any behaviours during the 12:00–16:00 (locomotion: U = 60.500, Z = −0.330, p = 0.834; resting: U = 59.000, Z = −0.472, p = 0.787; eating: U = 55.000, Z = −0.776, p = 0.610, OOS: U = 46.500, Z = −1.281, p = 0.291; vigilance and OOS not observed) and 20:00–00:00 (locomotion: U = 61.000, Z = −0.260, p = 0.881; resting: U = 44.000, Z = −1.258, p = 0.238; eating: U = 62.500, Z = −0.100, p = 0.928; OOS: U = 60.000, Z = −0.282, p = 0.834; vigilance and OOS not observed) time periods between event nights or non-event nights.

Within event nights and non-event nights, behaviour varied throughout the 12 h period (Figure 3). For data collected during non-event nights, there was a significant difference in average number of occurrences of resting (H = 26.705, df = 2, p < 0.001) and time spent OOS (H = 19.804, df = 2, p < 0.001). Resting was significantly lower from 12:00–16:00 than 16:00–20:00 (U = −11.562, p = 0.046) and 20:00–00:00 (U = −24.625, p < 0.001), and it was also lower during 16:00–20:00 than 20:00–00:00 (U = −13.062, p = 0.018). OOS behaviour was more frequent 12:00–16:00 than between 20:00–00:00 (U = 21.281, p < 0.001). The same differences were reflected in resting behaviour (H = 15.664, df = 2, p < 0.001) and periods of time spent OOS on event nights (H = 14.380, df = 2, p < 0.001). Resting was higher from 20:00–00:00 than from 12:00–16:00 (U = 13.562, p < 0.001). Average number of times the capybara were OOS were higher between 12:00 and 16:00 than between 20:00–00:00

(U = 12.688, p = 0.001). There was no difference in locomotion (H = 0.270, df = 2, p = 0.874) or eating (H = 5.812, df = 2, p = 0.055). Vigilance and ARBs were not observed regardless of whether or not the event was running.

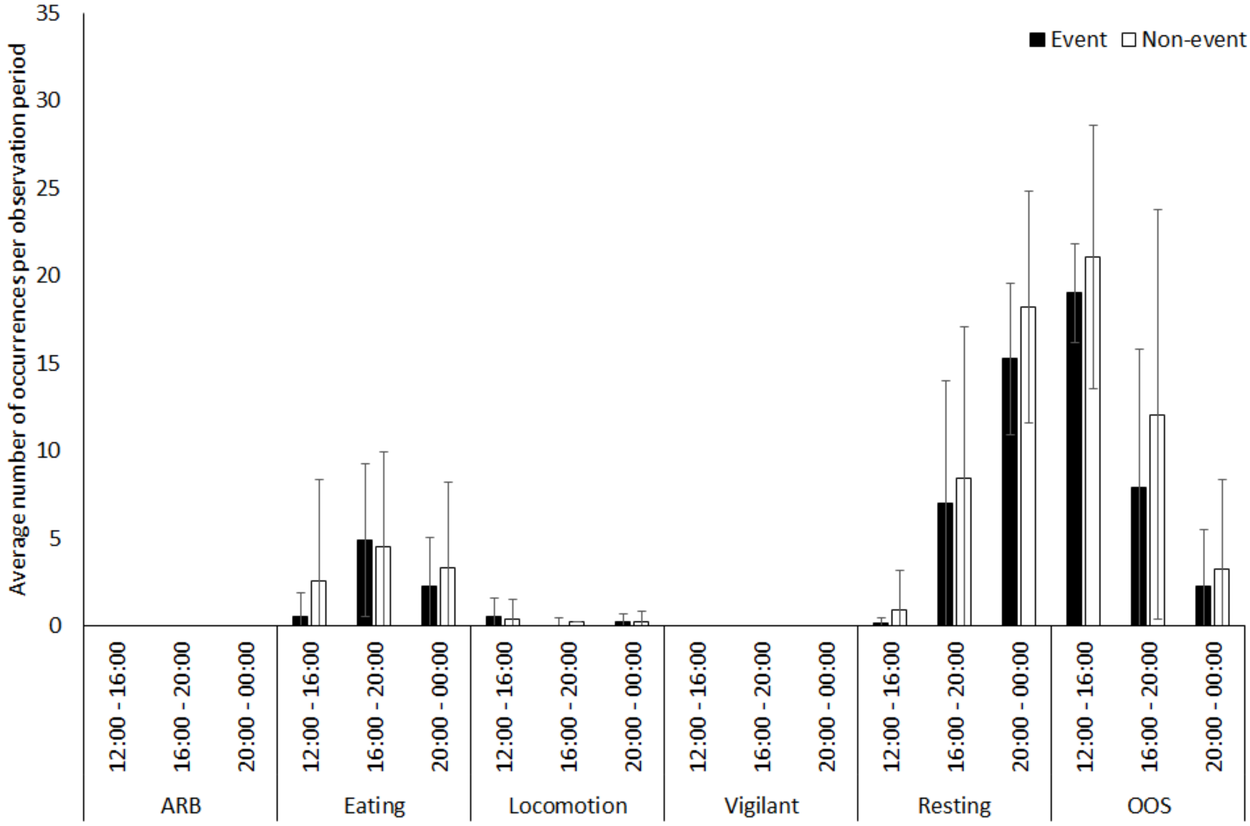

Figure 3. Activity budget data for four capybaras (average number of occurrences of each behaviour within the group per observation period ± standard deviation) from 12:00–00:00 during event nights and non-event nights at Knowsley Safari. Each 12 h was split into three time periods. ARB: abnormal repetitive behaviour, OOS: out of sight of the observer.

3.2. Vicuna

The vicuna spent most of their evenings from 16:00 to 20:00 out of sight of the observer, regardless of whether or not it was an event night (Figure 4). The vicunas were never observed performing ARBs. There were no differences in any of the recorded behaviours between 16:00 and 20:00 during event nights and non-event nights (locomotion: U = 782.000, Z = −0.758, p = 0.448; resting: U = 783.000, Z = −0.659, p = 0.510; vigilant: U = 783.000, Z = −1.439, p = 0.150; eating: U = 783.000, Z = −0.732, p = 0.464; OOS: U = 786.000, Z = −0.476, p = 0.634) (Figure 4). There were no other significant differences in behaviour across the three data collection points (before the event period, during the event period, after the event period).

There was some variation in behaviour throughout the 12 h period (Figure 5). Although statistically insignificant, more eating behaviour was observed, and periods out of sight of the observer were reduced (U = 32.000, Z = −3.019, p = 0.052 and U = 32.000, Z = −3.019, p = 0.052, respectively) between 20:00 and 0:00 on event nights as compared to non-event nights. There was no difference between event and non-event nights for locomotion (U = 56.000, Z = −1.414, p = 0.653) or resting (U = 40.000, Z = −2.558, p = 0.153). Vigilance and ARBs were not observed. From 12:00 to 16:00, there were no differences between the frequency of behaviours on event or non-event nights (locomotion: U = 62.000, Z = −0.162, p = 0.928; resting: U = 48.000, Z = −1.509, p = 0.350; vigilant: U = 60.000, Z = −0.707, p = 0.834; eating: U = 58.500, Z = −0.419, p = 0.742; time spent OOS: U = 63.500, Z = −0.036, p = 0.971). ARBs were not observed on either event nights or non-event nights.

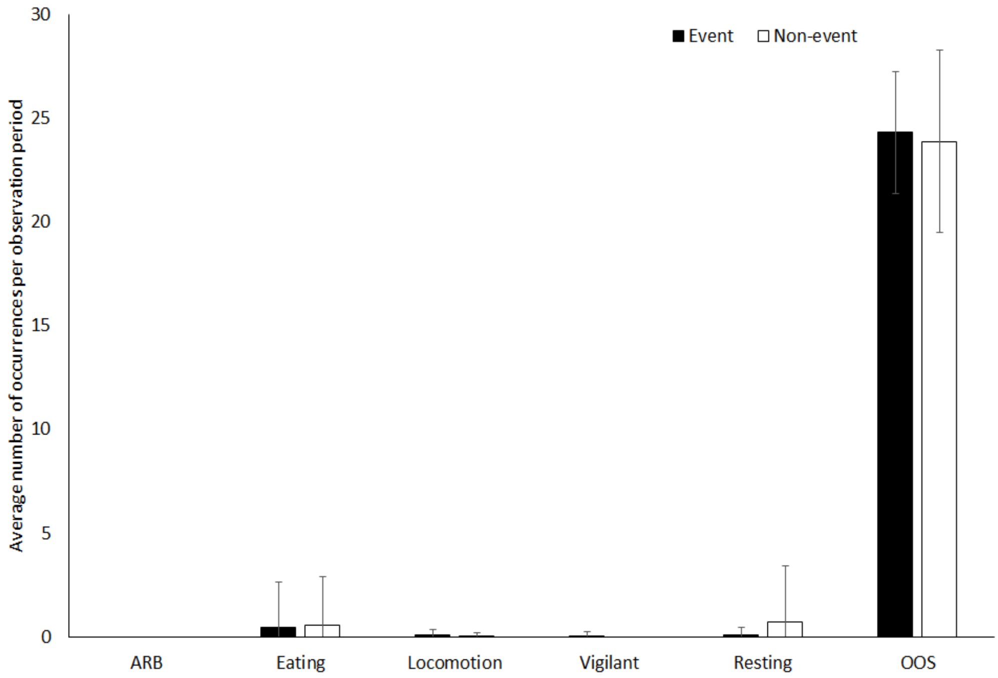

Figure 4. Activity budget data from 16:00 to 20:00 for five vicunas (average number of occurrences of each behaviour within the group per observation period ± standard deviation) on event nights and non-event nights at Knowsley Safari. ARB: abnormal repetitive behaviour, OOS: out of sight of the observer.

During non-event nights, time spent OOS varied throughout the evening (H = 6.235, df = 2, p = 0.044), with the vicuna spending more time out of sight from 20:00 to 00:00 than 12:00 to 16:00 (U = −7.531, p = 0.04). Locomotion varied slightly across time (H = 5.832, df = 2, p = 0.054). There were no other significant changes in behaviour throughout the evening (resting: H = 5.344, df = 2, p = 0.069; vigilance: H = 2.000, df = 2, p = 0.368; eating: H = 5.501, df = 2, p = 0.064). There were no differences in behaviour throughout the three time periods during the evening on event nights (locomotion: H = 0.575, df = 2, p = 0.750; resting: H = 4.442, df = 2, p = 0.109; vigilance: H = 2.000, df = 2, p = 0.368; eating: H = 1.736, df = 2, p = 0.420, time spent OOS: H = 1.868, df = 2, p = 0.393).

3.3. *Tapir*

There were no significant differences in average numbers of occurrences of locomotion (U = 741.000, Z = −0.596, p = 0.551), rest (U = 742.500, Z = −0.405, p = 0.685), eating (U = 648.000, Z = −1.406, p = 0.160) or time spent OOS (U = 682.500, Z = −1.137, p = 0.255) on event nights compared to non-event nights between 16:00 and 20:00 (Figure 6). Vigilant behaviour was only observed during event nights and was significantly higher than during non-event nights (U = 728.000, Z = −2.012, p = 0.044). There were no other significant differences in behaviour across the three data collection points (before, during, and after the event period).

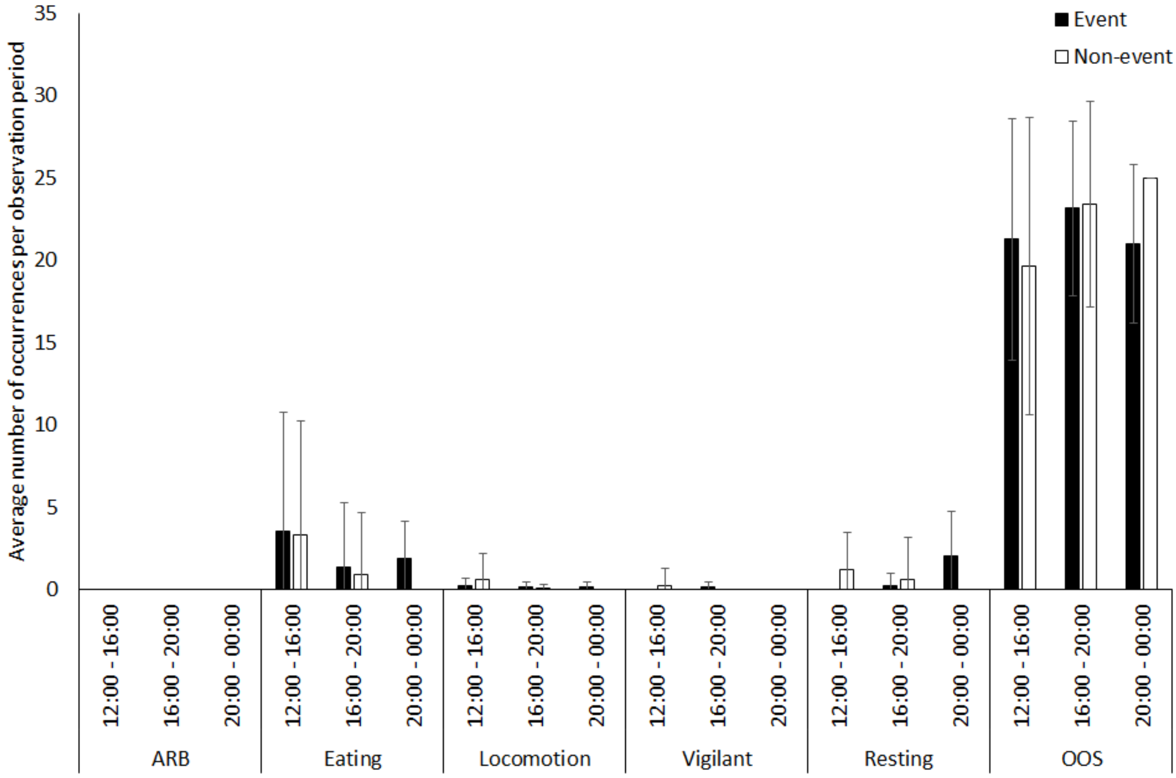

Figure 5. Activity budget data for five vicunas (average number of occurrences of each behaviours within the group per observation period ± standard deviation) from 12:00–00:00 during event nights and non-event nights. Each 12 h period was split into three time periods. ARB: abnormal repetitive behaviour, OOS: out of sight of observer.

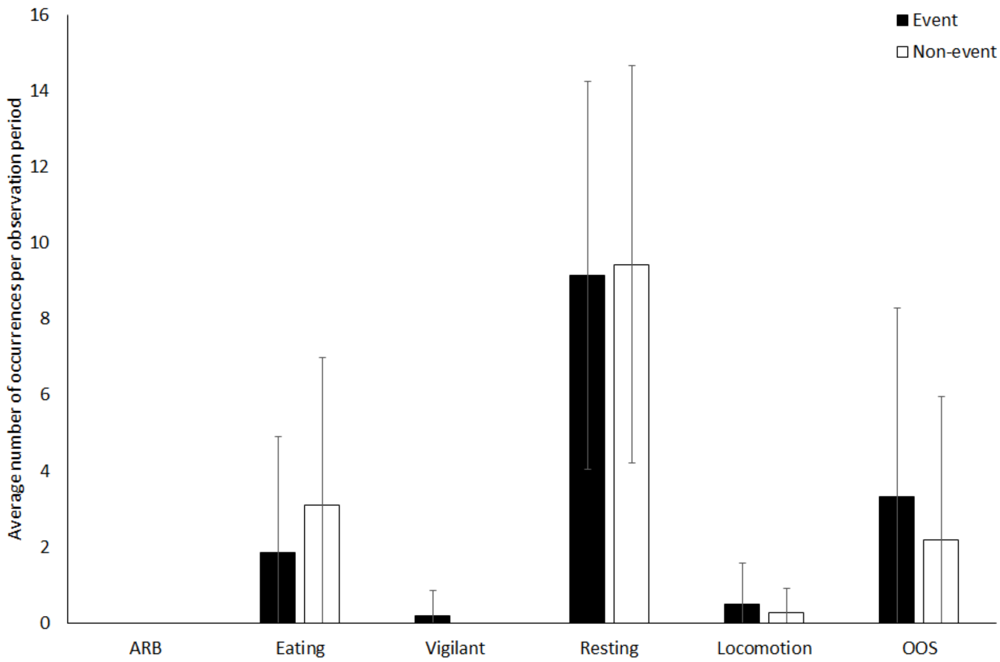

Figure 6. Activity budget data from 16:00 to 20:00 for three tapir (average number of occurrences of each behaviour within the group per observation period ± standard deviation) on event nights and non-event nights at Knowsley Safari. ARB: abnormal repetitive behaviour, OOS: out of sight of the observer.

Throughout the 12 h period there was no difference in average number of occurrences of behaviour between 20:00 to 00:00 on event nights and non-event nights (Figure 7; locomotion: U = 27.000, Z = −0.770, p = 0.645; resting: U = 18.000; Z = −1.539, p = 0.161; eating: U = 18.500, Z = −1.517, p = 0.161; time spent OOS: U = 30.000, Z = −0.256, p = 0.878). Vigilance and ARBs were not observed from 20:00 to 00:00. Reduced rest was observed from 12:00 until 16:00 on evenings when there were no events, although this was not statistically significant (U = 18.000, Z = −1.539, p = 0.051). There were no other differences in average number of occurrences of behaviours during non-event nights and event nights between 12:00 and 16:00 (locomotion: U = 102.500, Z = −1.521, p = 0.341; eating: U = 124.000, Z = −0.170, p = 0.897; time spent OOS: U = 96.500, Z = −1.405, p = 0.239). Vigilance and ARBs were not observed from 12:00 to 16:00.

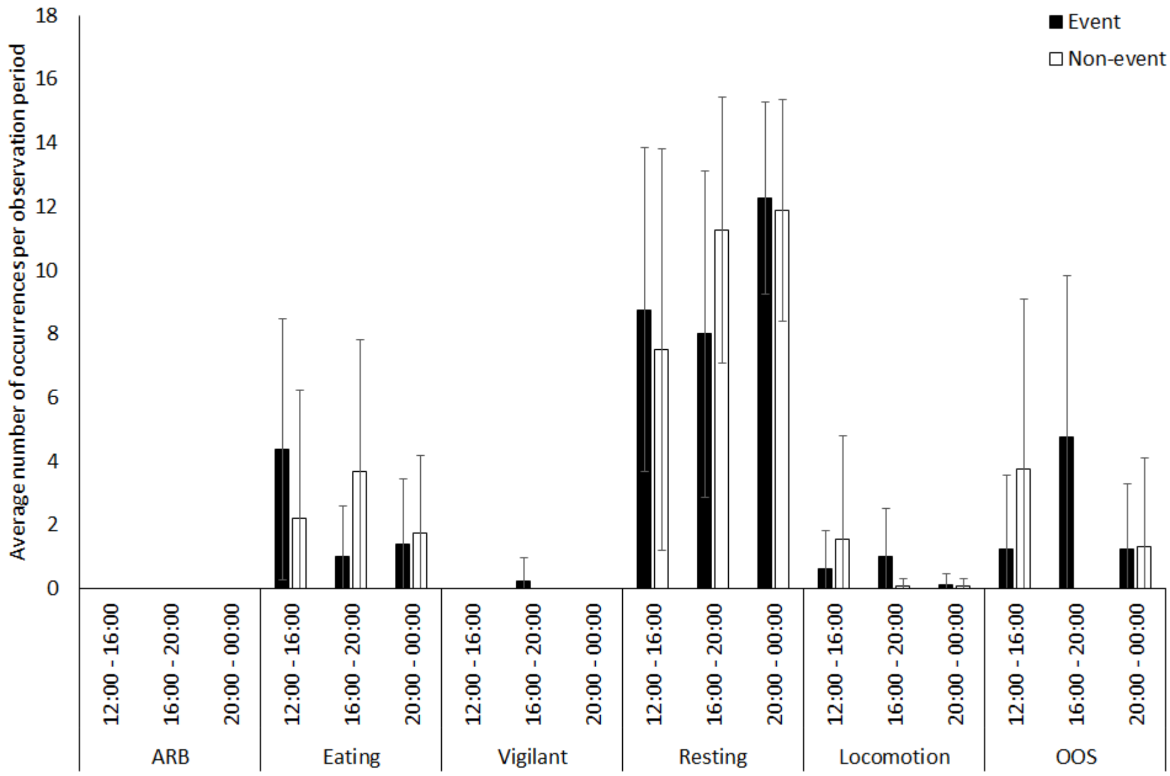

Figure 7. Activity budget data for three tapir (average number of occurrences of each behaviours within the group per observation period ± standard deviation) from 12:00–00:00 during event nights and non-event nights. Each 12 h period was split into three time periods. ARB: abnormal repetitive behaviour, OOS: out of sight of the observer.

Behavioural changes were observed across the time period. During non-event nights, occurrences of the tapir being out of sight varied throughout the 12 h period (H = 9.080, df = 2, p = 0.011), with time spent out of sight being higher from 12:00 until 16:00 than 16:00 to 20:00 (U = 10.969, p = 0.008). Locomotion, resting and eating did not differ across time (locomotion: H = 3.771, df = 2, p = 0.152; resting: H = 4.581, df = 2, p = 0.101; eating (H = 2.228, df = 2, p = 0.328). Vigilance was not recorded on non-event nights. Within event night observations, there were no significant differences in any of the behaviours over time (locomotion: H = 1.705, df = 2, p = 0.426; resting: U = 3.888, df = 2, p = 0.143; vigilant: H = 2.000, df = 2, p = 0.368; eating: H = 3.673, df = 2, p = 0.159; time spent OOS: H = 3.466, df = 2, p = 0.177). ARBs were not recorded on event or non-event nights.

3.4. Giraffe

The giraffe spent most of the time between 16:00 and 20:00 eating, regardless of whether it was an event or non-event night (Figure 8). There was no difference in the average number of occurrences of locomotion (U = 757.500, Z = −0.293, p = 0.769), ruminating (U = 682.500, Z = −1.713, p = 0.087), vigilance (U = 756.000, Z = −1.414, p = 0.157), eating (U = 652.500, Z = −1.357, p = 0.175) or ARBs (U = 756.000, Z = −1.414, p = 0.157) between event nights and non-event nights (Figure 4). Giraffes were never observed engaging in resting behaviour between 16:00 and 20:00, and there were very few overall observations of ARBs or vigilance behaviour. There were no other significant differences in behaviour across the three data collection points (before, during, and after the event period).

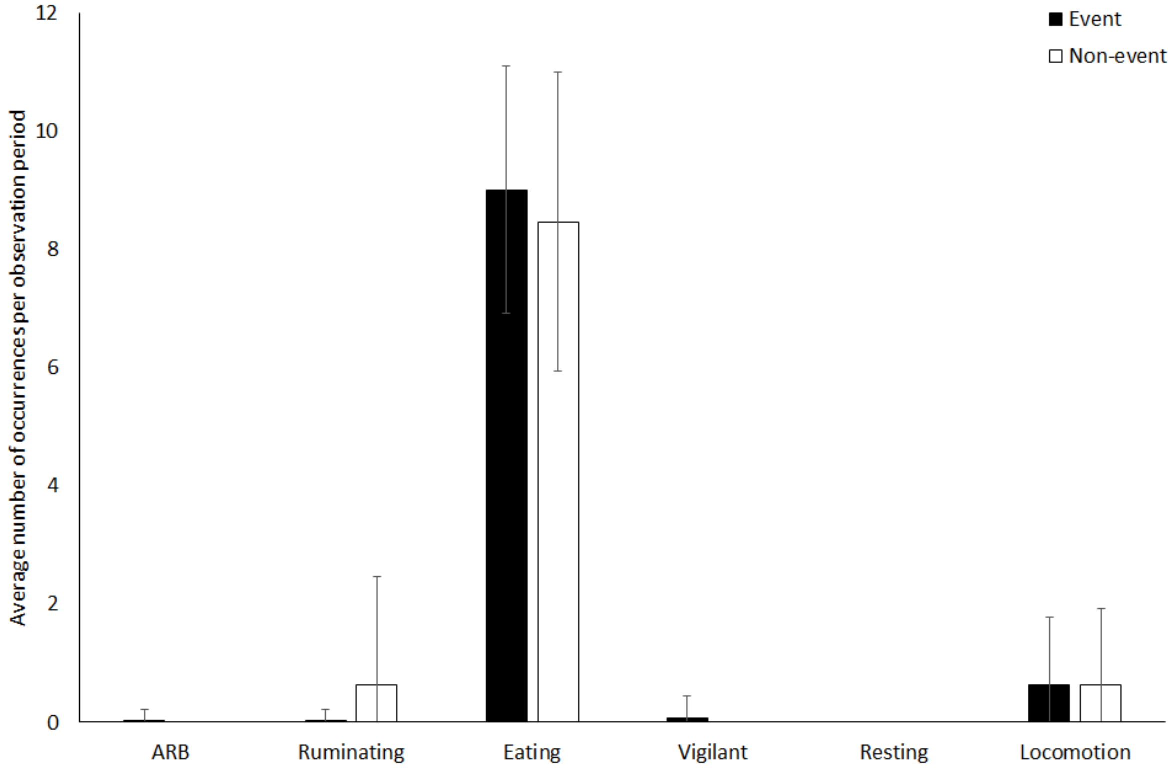

Figure 8. Activity budget data from 16:00 to 20:00 for two giraffes (average number of occurrences of each behaviour within the group per observation period ± standard deviation) on event nights and non-event nights at Knowsley Safari. ARB: abnormal repetitive behaviour, OOS: out of sight of the observer.

There was no difference in the average number of occurrences of any behaviours between 12:00 and 16:00 (locomotion: U = 46.000, Z = −1.204, p = 0.291; ruminating: U = 59.500, Z = −0.288, p = 0.787; vigilant: U = 60.500, Z = −0.447, p = 0.834, eating: U = 43.500, Z = −1.404, p = 0.214; ARBs: U = 56.000, Z = −1.414, p = 0.653; resting was not observed) and 20:00 and 00:00 (locomotion: U = 60.000, Z = −0.379, p = 0.834; ruminating: U = 47.500, Z = −1.106, p = 0.320; vigilant: U = 56.000, Z = −1.414, p = 0.653, eating: U = 57.000, Z = −0.534, p = 0.697) when comparing event nights to non-event night. ARBs and resting were not observed.

Behaviour varied throughout the 12 h period (Figure 9). For data collected during non-event nights there were significant differences in the average number of occurrences of locomotion (H = 6.123, df = 2, p = 0.047), ruminating (H = 6.235, df = 2, p = 0.044), resting (H = 27.484, df = 2, p < 0.001) and eating (H = 19.851, df = 2, p < 0.001). Locomotion was greater between 12:00 and 16:00 than between 20:00 and 00:00 (U = 10.438, p = 0.049). Rumination activity was greater between 12:00 and 16:00 than from 16:00 to 20:00 (U = 9.906, p = 0.044). Resting was not observed between 12:00 and 20:00. Resting was significantly higher between 20:00 and 00:00 than both 12:00–16:00 and 16:00–20:00 (U = −16.500, p < 0.001). Eating had a higher average number of occurrences between 12:00 and 16:00 and 20:00 and 00:00 than between 16:00 and 20:00 (U = −17.906, p < 0.001 and U = 17.813, p < 0.001, respectively). For data collected during event nights differences were seen in resting (H = 18.251, df = 2, $p < 0.001$), eating (H = 12.431, df = 2, $p = 0.002$) and ruminating (F = 4.581, df = 2, $p = 0.022$). Resting was not recorded between 12:00 and 20:00 and was significantly higher between 20:00 and 00:00 than either of the earlier periods (U = −10.500, $p = 0.01$). Eating was higher between 16:00 and 20:00 than between 20:00 and 00:00 (U = 11.750, $p = 0.002$). Ruminating was higher from 20:00 to 00:00 than from 16:00 and 20:00 ($p = 0.028$). There was no difference in vigilance (H = 1.045, df = 2, $p = 0.593$), locomotion (H = 1.799, df = 2, $p = 0.407$) or ARBs (H = 2.000, df = 2, $p = 0.368$) over the 12 h.

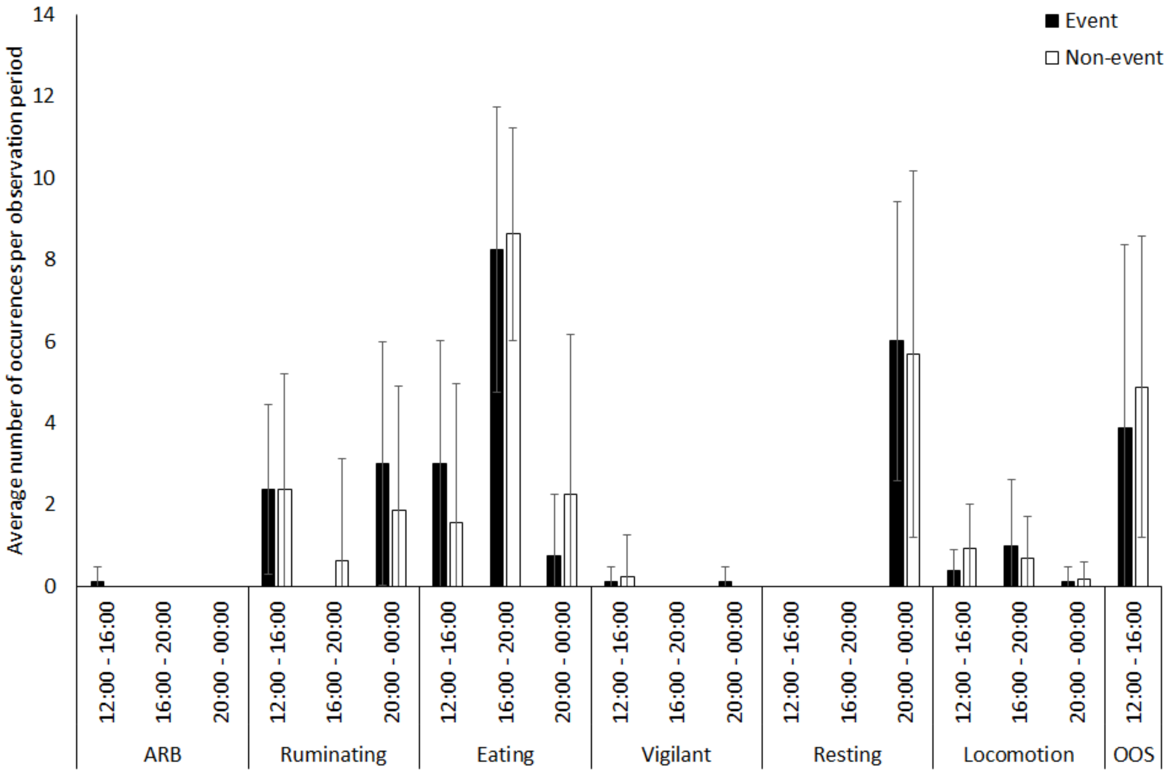

Figure 9. Activity budget data for two giraffes (average number of occurrences of each behaviour within the group per observation period ± standard deviation) from 12:00–00:00 during event nights and non-event nights. Each 12 h period was split into three time periods. ARB: abnormal repetitive behaviour, OOS: out of sight of the observer.

4. Discussion

The Christmas light event at Knowsley Safari ran from mid-November to the end of December 2022. During the event, the focal animals (a selection of four species housed in the foot safari area) were exposed to a range of external stimuli, both from the event itself (e.g., music and lights) and also from the visitors (e.g., visitors in the zoo later than usual). Some behavioural changes were observed when comparing between 16:00 and 20:00 on nights when the event was held and nights when events were not; however, these were limited, and there were no particular indicators of negative implications of the event across the study species. A small set of data analysed over a 12 h period indicated behavioural variation across the 12 h, but no particular patterns across all species in relation to whether or not an event was being held. These findings mirror the mixed behavioural responses seen in other species in relation to zoo events [6,9–11]. Reasons for these changes, or lack thereof, are explored in more detail at a species level below.

4.1. Behavioural Changes

Several factors may impact animal behavioural response to zoo visitors, including individual personality and previous experiences [27]. Evening events, and events outside of regular operating hours can provide increased exposure to stressors to zoo animals;

in the form of visual and auditory stimuli, plus visitors outside of zoo opening hours. Evening events have had various impacts on zoo species, with different event types eliciting varied responses across species [6,9–11]. Recent research has highlighted 'risk' factors for species that may be most likely to be impacted [12]. Species identified at greater risk of being negatively affected by zoo visitors are terrestrial, herbivorous/omnivorous and diurnal species from closed habitats. Drivers influencing these risks include species from closed habitats, which are less accustomed to humans; diurnal species which have their routines altered by the presence of people during zoo opening hours; herbivorous species (flight/prey species) and terrestrial animals, which are typically more exposed within their enclosures than arboreal species [12]. The species in this study predominantly fall into these 'high-risk' categories. However, with the exception of the giraffe, all animals had the choice of moving closer to or further from the event stimuli by changing their position in their enclosures and moving from outside areas to inside areas. Furthermore, zoo species are used to the presence of humans. Recent research during the COVID-19 pandemic has suggested that they are habituated to these environments and can control their own experiences through modified behaviour in the presence and absence of zoo visitors [15].

Activity patterns in wild animals are predominantly driven by competition and predator/prey interactions [12]. Using the framework of likelihood of disturbance owing to animal activity, as the event is in the early evening and after sunset, it is most likely to theoretically impact on crepuscular and nocturnal species. Wild capybaras are generally crepuscular but able to adapt to a nocturnal lifestyle in areas of high predation or human impact [28,29]. Tapirs are generally crepuscular and nocturnal but may be active during the day [30]; giraffes and vicuna are typically diurnal, with giraffes spending much of the day feeding [31,32]. Within the zoo environment, all these species are diurnal and often seen by the public during zoo opening hours. Whilst this may be different to their natural behavioural ecology, this behaviour shift is likely due to the change in active hours owing to the lack of predators and the presence of keepers and visitors during daylight hours. Diurnal activity can thus be considered normal for these species.

4.1.1. Capybara

OOS was a common observation, and capybaras spent significantly less time out of sight during event nights. No other significant behavioural changes were observed in the capybara between event night and non-event nights between 16:00 and 20:00. Resting followed a similar pattern throughout the 12 h period observations between 12:00 and 00:00, increasing as the day progressed. Vigilance and ARBs were never recorded. Owing to the position of the cameras and the design of the enclosures, for the capybara (and the other species in the exhibit, the tapir and vicuna), animals being out of sight meant the animals were in the outside paddock where they could more clearly see and hear the event, rather than being in their house (Figure 1).

The observed reduction in observations of the capybara being OOS during event nights meant that the capybaras were spending more time within the inside areas of their enclosure between 16:00 and 20:00 on event nights. In the 12 h observation periods, capybaras were OOS more between 12:00 and 16:00 than between 20:00 and 00:00, regardless of whether an event was on. This suggests they are utilising their outdoor paddock more during the daytime than the evening time, which is to be expected at the time of year in which the study was undertaken and may not be directly related to the event. The outside paddock is in full view of the range of stressors identified as potential impacts of evening events (e.g., lights, large groups of visitors, noise). It could therefore be suggested the capybara were choosing to make more use of the house, which is off-show and fully enclosed, as a result of the event disrupting their outside space. The importance of enabling captive animals to make choices over their own environments has been highlighted in the literature [33–35]. Species have been recorded using indoor, off-show spaces preferentially to avoid noise, even when other welfare indicators remained unchanged [36], and the ability to move to an area without visitors can reduce stress associated with visitors [37,38]. Considering this, it is possible that the evening event was stressful for the capybara, but the opportunity to choose to avoid the event prevented an overall negative impact. Similar changes to enclosure use have been observed in some species when zoological facilities opened after the COVID-19 facility closures [39,40]. However, behavioural changes did not always correspond with increased cortisol, which suggested animals were behaviourally controlling their stress levels caused by the changing environmental situations [13,15]. This research further supports the importance of enabling animals to make choices within their environments. It is impossible to ascertain what the capybaras were doing when they were out of sight of the observer. Having fuller views of the enclosure is advocated for future research to capture behavioural changes alongside enclosure-use data.

4.1.2. Vicuna

The period of time the capybara spent OOS contrasts with that of the vicunas. Despite the vicuna having similar choices available to them, they were almost exclusively out of sight for the duration of the research, regardless of whether it was an event or non-event night or whether it was the focus 16:00–20:00 period or the twelve-hour observation period. Without being able to observe the vicunas, it is impossible to draw further conclusions about the impact of the event on their activity budget, but the similarity between event nights and non-event nights is suggestive that their fundamental enclosure use was not impacted. This highlights the importance of considering species differentiation when making management plans for such events. As with the capybara, undertaking research to understand what they were doing whilst out of sight is of paramount importance to ensure they were still undertaking a range of species-typical behaviours during observations and the only way to conclude there are no negative implications for this species.

4.1.3. Tapir

Tapir were predominantly recorded resting, and there was no difference in duration of rest regardless of whether it was an event night or not during the focal 16:00–20:00 period. Vigilance was only recorded on event nights during both the 16:00–20:00 focal observations and the 12 h observations. This was significantly higher on event nights than non-event nights during the 16:00–20:00 focal observation periods, but the rates of vigilance were still very low. There was no significant difference from 12:00–16:00, and no vigilance was observed after 20:00 in any condition. During the 12 h observation periods, there was reduced rest from 12:00 until 16:00 on evenings when there were no events. In the 12 h recordings, time spent OOS varied over time on non-event nights, with more time spent out of sight (i.e., tapir in the outside paddock) between 12:00–16:00 than 16:00 and 20:00. This would be expected from a diurnally active species, given that event was hosted and the study was undertaken in the winter and may be more reflective of animal response to natural environmental conditions than the event itself. Zoo animals have been observed to change their behaviour and enclosure use seasonally [41].

The valence of the observed vigilance behaviour is unknown. It could be a sign of intrigue or interest rather than an indicator of stress, particularly as no other behavioural indicators of compromised welfare were observed. Although not significant, descriptively, more time was spent OOS (i.e., the tapir utilising the outside paddock) from 16:00 to 20:00 on event nights than non-event nights, which supports the hypothesis of intrigue in relation to the event and associated visitors rather than a negative stressor. When stimulating behaviours such as vigilance that would be common in the wild, eustress can be positive for behavioural diversity in captive animals [42]. Whilst behavioural diversity alone cannot be used as a reliable indicator of positive welfare [43], it is important to acknowledge the potential benefits of stimulating behaviour that may not arise regularly.

4.1.4. Giraffe

The giraffe spent most of the 16:00–20:00 focal observations eating, regardless of whether or not an event was being held. This can be attributed to the provision of hay just before observations started each day. There was no difference in giraffe behaviour during the 16:00–20:00 focal period or between 12:00 to 16:00 and 20:00–00:00 on event nights or non-event nights. However, behaviour was variable throughout the 12 h period, and the differences within the 12 h period varied according to event nights or non-event nights. Locomotion was greater before 16:00 than after 20:00. On non-event nights, eating was more frequent between 12:00–16:00 and 20:00–00:00 than from 16:00–20:00, with more rumination between 12:00–16:00 than 16:00–20:00. On event nights, giraffes spent more time eating from 16:00–20:00 than 20:00 to 00:00 and rumination was greater between 20:00 and 00:00 than 16:00–20:00. Resting increased after 20:00 on both event nights and non-event nights. This likely reflects their usual resting patterns and activity [44].

During our observations, the giraffe did not have access to their outside paddock. Limiting the giraffe's access to the outside enclosure is part of standard winter management practices and best practice recommendations (due to the cold, wet weather conditions in northwest England from November to February) [44,45]. This likely reduced the exposure of the giraffe to the event and any possible stressors the event may have presented. The lack of negative behavioural responses and minimal behaviour change supports this concept, with behaviours observed likely being a product of management/husbandry (e.g., food provision) than responses to the altered environment during events.

4.2. Limitations and Areas for Future Research

Evening events may disrupt animal routines and expose them to novel stressors. As long as no indicators of extreme poor welfare are present, changes to behavioural patterns are not considered a problem per se. However, impact on species needs to be more clearly understood. The results of this work indicated relatively minimal impact of the evening event, which mirrors research outputs on this area, particularly on events such as this with a focus on lights [46]. The greatest impacts in other research were seen in response to loud fireworks rather than music, and when screams were made by members of the public [10,18]. Whilst the zoo soundscape is variable, low-level background noise created by zoo visitors is unlikely to cause negative implications for zoo animals. Rather it is the more extreme noise levels which can cause more of an issue. During this event, the decibel level was not assessed. However, this would be a recommended area for further research as some music is featured. Here, time spent OOS was used as a rudimentary measure of proximity to the event. More detailed information on space use and how that relates to the sound environment and visitor details at the enclosure during the event would be beneficial in fully understanding the event's impact.

The data collection methods were designed to be simplistic to enable this research to be undertaken in a timely fashion throughout the period of the event. Whilst this may have led to a loss of highly detailed data, loss of data is more likely to be a problem for the accuracy of recording event behaviours rather than state behaviours [26]. Indeed the use of regular sampling over more extended periods has been advocated for use in zoo and aquarium settings to estimate behavioural patterns [26]. The use of hourly scans has proven suitable for capturing behavioural changes in relation to specific events in zoo-housed species [6], and five-minute observation periods have been utilised in other 'visitor effect' literature to gather general behavioural overviews [47–49], as was the aim of this research. Infrequent and brief monitoring has been identified as a valuable monitoring tool that can be used as a suitable starting point for tracking basic activity and identifying changes in behaviour [50]. Therefore, its application enables a better understanding of the impacts of evening events on zoo animals in a quick and manageable time frame. However, it is important to validate such methods in terms of understanding the degree to which they represent fuller behavioural patterns. The development of validated protocols which enable 'snapshot' welfare assessments during events would provide the opportunity for evidence-based, animal-focused approaches to event management on a bigger scale. To thoroughly investigate impacts on behavioural rhythms and wider implications for animals, it is recommended that future research gather data over a more extended period. We suggest animal behaviour is monitored across a 24 h period in recognition of the potential for a 'lag', with impacts of events on animal behaviour potentially being observed more the day following the event [17]. Additionally, 24 h observations would enable us to determine whether there are impacts from the evening events in terms of the presence of displacement behaviours, as has been observed in human–animal interaction research [51]. Corroborating behavioural observations with physiological indicators of stress throughout the 24 h period would also be beneficial to ensure that behavioural changes, even minor, are not being mirrored physiologically. We recommend collections seek to maximize choice available to animals during out of hours events and suggest further mitigation is considered when evidence suggests it is necessary, e.g., soundproofing, screening, provision of additional retreat spaces, etc. While these data cannot be automatically extrapolated to other species or other events, this work is an important contribution to our understanding of the potential impacts of evening events on zoo animals, and it adds further knowledge in terms of which aspects of events may or may not be impacting animals in different ways.

5. Conclusions

Proactive evidence-based management is vital to continue to maintain and increase the positive welfare experiences of zoo animals. Evening events are becoming increasingly popular as zoos actively market to increase visitor footfall and alternative revenue streams. However, unique stressors, including disrupted routines, large numbers of visitors and loud, unexpected or unpredictable noises may accompany evening events. Thus, there is the potential for animals to be adversely affected by evening events. Research to date has highlighted the mixed response of animals to evening events, and it is possible that this relates to the behavioural ecology of species. Here, the study species were considered to be at the highest risk of disturbance based on their behavioural ecology. Behavioural changes were seen in the study species, but no overt signs of a negative impact of the events were observed. It is likely that they are behaviourally adapted to the range of different environmental conditions experienced at the zoo, and that by providing the animals with choice they were supported in undertaking behaviours which provided them with the most comfortable environment, thus minimising negative impacts of the event. It is advocated that future research builds on this data set by undertaking more detailed observations throughout the 24 h period both during events and on days/nights when no events are being held.

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Data Availability Statement: Data are available from the corresponding author upon reasonable request.

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