# Communication from the zoo: reports from zoological facilities of the impact of COVID-19 closures on animals

by Hunton, V., Rendle, J., Carter, A. and Williams, E.



Hunton, V., Rendle, J., Carter, A. and Williams, E. (2022) 'Communication from the zoo: reports from zoological facilities of the impact of COVID-19 closures on animals', *Journal of Zoological and Botanical Gardens*, *3*(2), pp.271-288.

Journal of
*Zoological and Botanical Gardens*

MDPI

*Article*

# Communication from the Zoo: Reports from Zoological Facilities of the Impact of COVID-19 Closures on Animals

**Violet Hunton [1], Jessica Rendle [2,3], Anne Carter [4,†] and Ellen Williams [1,*,†]**

[1] Department of Animal Health, Behaviour & Welfare, Harper Adams University, Newport TF10 8NB, UK; violet_hunton@hotmail.co.uk
[2] Conservation Medicine, College of Science Health, Education and Engineering, Murdoch University, Perth, WA 6150, Australia; j.rendle@murdoch.edu.au
[3] School of Veterinary Medicine and Science, Sutton Bonington Campus, University of Nottingham, Sutton Bonington LE12 5RD, UK
[4] School of Animal, Rural & Environmental Sciences, Brackenhurst Campus, Nottingham Trent University, Nottingham NG25 0QF, UK; anne.carter@ntu.ac.uk
* Correspondence: ewilliams@harper-adams.ac.uk
† These authors contributed equally to this work.

**Abstract:** Zoos engaged in a range of communication types with prospective visitors during the temporary closures necessitated by the COVID-19 pandemic. This study sought to (1) investigate social media reports and public responses to zoo-animal-related posts over a one-year period during COVID-19 lockdowns; (2) understand the use of reporting language in news articles concerning animal responses during zoo closures, and to investigate whether this differed across species; and (3) investigate how keepers perceived general animal behavior, and how they perceived animal behavior in keeper–animal interactions, during the COVID-19 facility closures. Data were collected from BIAZA-accredited zoos' Facebook pages (March 2020 to March 2021) and news reports (Google search outputs from 20 March to 5 April 2021). Keeper perceptions were captured via questionnaires (May to August 2021). Data were collected on taxa, the reported behavioral changes and the language used in media communications. In Facebook posts and news reports, mammals were more frequently represented than was expected ($p < 0.05$). Behavioral responses were more frequently negative ($p < 0.05$) and less frequently positive or neutral ($p < 0.05$). Keepers reported overall behavioral changes, as well as changes during their own interactions with animals. On Facebook, mammals were described using a combination of behavioral descriptions and anthropomorphic terms, which were used more frequently than was expected ($p < 0.05$). In the news reports concerning primate species, anthropomorphic descriptions were used more frequently than expected ($p < 0.05$), while behavioral descriptions were used less frequently than expected ($p < 0.05$). The reports regarding the Carnivora were the reverse of this. This study enabled an understanding of the impact of the temporary closures on the animals, and how this impact was communicated to the public. The findings may reflect the relationships that humans have with animals and the need for communication methods that will capture visitors' interest and induce empathy with the various species.

**Keywords:** communication; zoo closures; visitor–animal interactions; keeper–animal interactions; social media; COVID-19



**Citation:** Hunton, V.; Rendle, J.; Carter, A.; Williams, E. Communication from the Zoo: Reports from Zoological Facilities of the Impact of COVID-19 Closures on Animals. *J. Zool. Bot. Gard.* **2022**, *3*, 271–288. https://doi.org/10.3390/jzbg3020022

Academic Editors: Ashley Edes and David Powell

Received: 14 April 2022
Accepted: 8 June 2022
Published: 15 June 2022



## 1. Introduction

Zoological institutions, hereafter known as zoos, provide an important public service, practicing and supporting animal welfare, conservation and education [1]. The facilities themselves and the work the organizations undertake are predominantly funded by entrance fees and visitor donations [2]. Before the COVID-19 pandemic, zoos worldwide welcomed more than 700 million visitors each year [3]. COVID-19 restrictions led to a number of limitations on zoos, including repeated temporary closures and limited visitor

numbers during opening times. This led to significant financial implications that had both short- and long-term effects on the revenue of zoos and their subsequent conservation activity. Visitors to Chester Zoo (UK) exceeded 2 million in 2019, but fell to 1.2 million in 2020 [4]; 'Living Coasts' Torquay, located in Torbay, Devon (UK) was forced to close in June 2020 [5] due to a COVID-19-related funding shortfall, while Phoenix Zoo (USA) lost USD 80,000 per day during their temporary closure in March 2020 [6].

Reductions in zoo visitors during the COVID-19 pandemic were recently highlighted by one zoo as being one of their top three perceived conservation challenges [7]. Zoos needed to rethink their approach to raising the funds necessary to cover their running costs and to support their ancillary work [8]. Social media provides a powerful means of communicating with people who may be interested in supporting the work of zoos [9]; online fundraising became a key source of income during COVID-19 lockdowns and zoo closures [8]. Zoos were encouraged by zoological organizations, such as the British and Irish Associations of Zoos and Aquaria (BIAZA), to engage with the public and to communicate a positive message to their audiences, using the hashtag '#BIAZAbrightside' [10]. This gave rise to various ideas such as 'online keeper diaries', 'virtual zoo tours' and actual/physical zoo tours giving the animals an opportunity to walk around the zoo, which were documented and posted online. Another platform for sharing information about the plight of zoos during the pandemic was the use of international media articles. These articles showed a particular interest in the likely impact of the sudden loss of visitors, and subsequent visitor-animal interactions, on zoo animals [11].

The representation of animals in the media during the pandemic has varied, depending on species and circumstances. Zoo animals received less media attention than companion animals or in situ wildlife and were predominantly portrayed as victims of the pandemic [12]. This may have been an intentional tactic to induce empathy for the animals. Empathy for animals may be encouraged by the use of anthropomorphism [13]. Anthropomorphism is the attribution of human characteristics or human behaviors to any non-human entity [14]. Fischer [15] identified two principal types of anthropomorphism regarding animals: 'imaginative anthropomorphism', which is the representation of imaginary or fictional characters as human-like, and 'interpretive anthropomorphism', which is the attribution of human mental states to non-human animals and is the type of anthropomorphism used and referred to within this work. Higher public engagement on social media platforms has been achieved by the use of anthropomorphism [16]. Empathy for animals has been linked with environmental self-efficacy, and both environmental self-efficacy and empathy for animals are related to the intent to take conservation action [17]. Empathy is also considered to be an internal motivator for pro-environmental behavior change [18]. It follows that inducing empathy in the public may lead to increased financial support for zoos during and following a period of extreme hardship, such as in the COVID-19 pandemic.

The impact of COVID-19 on zoos has not been merely financial in nature. The visiting public are also an important part of the animals' environment [1]. The concept of 'human–animal relationships' and 'human–animal interactions' has been widely reported in the literature since the 1980s, with increasing prevalence in recent years. Visitors have been identified as a form of enrichment for some species [19–26], a negative stressor for others [25–28] and a neutral factor for others [29–31]. The sudden closure of zoological collections during 2020, as a result of the COVID-19 pandemic, led to facilities abruptly closing their doors to visitors, during a period of time when zoos in the Northern hemisphere were beginning to experience higher numbers of visitors as they entered the spring/school holiday season. These closure periods led to a unique opportunity to further understand the zoo-animal–visitor dynamic, with the possibility of a comparison of animal behavior at times when visitors were present with those times when there were 'no visitors'.

Quantitative research undertaken during the pandemic indicates mixed behavioral responses to the closures in zoo animals. Slender-tailed meerkats (*Suricata suricatta*) engaged in more positive social interactions and less alert behavior when visitors were present

than during the closures [32]. Giraffe (*Giraffa camelopardalis tippelskirchi*) showed reduced vigilance when visitors returned to zoos, following the closure period [33]. Grevy's zebra (*Equus grevyi*) engaged in more comfort behavior and spent more time close to the public viewing areas during the closure periods [34]. Red kangaroos (*Macropus rufus*) spent more time in proximity to one another and displayed increased inactivity and restricted space usage when the zoos reopened [35]. Amphibians [36] and cheetahs (*Acinonyx jubatus*) were less visible when visitors returned to the zoos [33]. Other species (e.g., African penguins (*Spehniscus demersus*), Nile crocodiles (*Crocodylus niloticus*) and flamingoes (*Phoenicopterus chilensis*)) showed no, or negligible, changes in behavior or enclosure usage [2,32,37].

The closure periods and temporary absence of visitors thus appear to have had variable impacts on zoo animal behavior. However, the behavior of animals may also have been affected by protocol changes resulting from the virus control measures imposed on visitors and staff, not merely by the absence of visitors. One example is the mandatory use of face masks to protect against pathogen transmission. By July 2020, nearly 90% of the world's population were using, or were advised to use, face masks [38]. Faces are an important visual stimulus for all major vertebrates [39] and the recognition of human faces has been identified in both vertebrate [39–44] and non-vertebrate taxa [45,46]. Zoo animals are able to differentiate their keepers from the general zoo visitors [47] and they show different frequencies of human-directed behavior to their keepers than they do to the public or to other workers in the zoo [48]. Within their zookeeping teams, zoo animals differentiate between individuals and will form unique relationships with specific individuals [49]. Animals may differentiate between individual humans using facial markers or facial expressions [50–52]. Since face masks change the facial appearance and conceal facial expressions, it may be that masks affect the ability of animals to read human facial expressions and, thus, altered the behavioral responses of the captive animals to humans in masks. Reports from ex situ research suggested that wildlife were changing their behavior in response to the use of face masks. The Nubian ibex (*Capra nubiana*) showed increased vigilance behavior [53], while Eurasian tree sparrows (*Passer montanus*) showed reduced fear responses when face masks were worn [54].

Many quantitative studies conducted within zoos during the pandemic were limited by staff availability and the requirement of gathering data in very restrictive environments. Our research takes a broad approach, utilizing outputs from zoos via social media, online media articles and keeper consultations. This gives us the opportunity to qualitatively review the various reports of animal behavior during COVID-19 closure periods, and to understand the way that any behavioral changes (or lack thereof) were being communicated to the public. This research comprised three main aims: (1) to investigate social media reports and public responses to zoo-animal-related posts over a one-year period during COVID-19 lockdowns; (2) to understand the use of reporting language in news articles concerning animal responses during zoo closures, and to investigate whether this differed across species; (3) to investigate how keepers perceived general animal behavior, and how they perceived animal behavior in keeper–animal interactions, during the COVID-19 facility closures.

Based on the previous literature [2,32–34,36,37] we predicted that reports on social media would indicate mixed responses to the closures, but that they may have been biased toward animals experiencing negative impacts (e.g., missing interactions with zoo visitors), owing to the need for zoos to continue to encourage support from members of the public and the #BIAZAbrightside campaign [10]. We also predicted that mammals would be more frequently represented than any other species, due to the taxa bias that is still generally reported [55,56], and that species that were more genetically similar to humans (e.g., primates) would be anthropomorphized more frequently than other species [14,57].

## 2. Materials and Methods

Three sources were used for data collection: (1) Facebook posts published by BIAZA-accredited zoological facilities in the UK and Ireland (hereafter, BIAZA zoos); (2) general

online news/media reports, circulated in the national and international mainstream media (hereafter, news reports); (3) a zookeeper questionnaire, designed to capture data on keeper perceptions of animal behavior during the COVID-19 closures and on animal responses to the use of face masks during keeper–animal interactions. The data obtained from this combination of sources was designed to achieve a wide-ranging understanding of how the behavior of zoo animals was affected by COVID-19 closures and how any changes were being communicated to the public.

### 2.1. Social and National Media

An overview of the search terms used, search methods, search dates and data extracted from Facebook posts and news reports is given in Table 1. Search terms were chosen following a pilot study, with a view to capturing a wide range of relevant data. To ensure consistency between communication methods, the same search terms were used for both Facebook posts and news reports. If any news report contained more than one species or report of animal behavior, these items were then broken down into separate statements. Duplicated Facebook posts/news reports were removed prior to analysis. Only articles written in English were included in the analysis, in order to reduce the risk of errors in interpretation or misunderstandings due to the nuances of language in translated articles.

**Table 1.** An overview of the search terms applied to social and national/international media.

| Source | Search Terms | Search Method | Dates Included | Data Extracted |
|---|---|---|---|---|
| Facebook | 'Animal Behavior'<br>'Bored'<br>'Closure'<br>'Coronavirus'<br>'COVID'<br>'COVID-19'<br>'Depressed'<br>'Lockdown'<br>'Looking for'<br>'Lonely'<br>'Missing'<br>'Public'<br>'Reopen'<br>'Visitors'<br>'Zoo' | Search bars on the Facebook pages of BIAZA-accredited zoos ($n$ = 122)<br>Search terms used in turn | March 2020–March 2021 * | Post date<br>Country in which the zoo was located<br>Number of reactions to the post<br>Number of comments on the post<br>Animal taxon and order<br>Animal common name<br>Reported behavioral change |
| Online media-Google search engine | **<br>Level 1: 'Zoo'<br>Level 2: 'COVID/coronavirus'<br>Level 3: 'Lock-down/closure/reopen'<br>Level 4: 'Depressed/bored/looking for/missing/lonely/visitors/public'<br>Level 5: 'Animal behavior' | The first four pages of a Google search engine output † | 20 March–5 April 2021 ‡ | Date<br>Publisher/news outlet<br>Country<br>Zoo<br>Animal taxon and order<br>Animal common name<br>Reported behavioral change |

* The commencement of the study period corresponded with the initial government lockdowns in Ireland (12 March 2020) and the UK (23 March 2020). ** Search terms were applied using 5 levels. Where these levels contained more than one search term, each term was applied in turn, in conjunction with the words at the other levels. For example, the first search applied was "zoo COVID lockdown depressed animal behavior", and then "zoo Coronavirus lockdown depressed animal behavior". This combinational approach to the 14 search terms led to 31 separate searches. † News reports were captured from only the first four pages of each search output in order to capture the most relevant information without being exhaustive in the methodology. ‡ Searches were undertaken from 20 March to 5 April 2021. All relevant reports found during these searches were included in the review, regardless of publishing date.

Posts/reports were also classified as 'anthropomorphic', 'behavioral', or a combination of both (Table 2). The valence of posts/reports was classified as 'negative' (e.g., the behavioral response to the closure was negative, in that the animals may not have been displaying behaviors that indicated poor or reduced welfare, but they were reportedly showing behaviors indicating that they had been negatively impacted by the lack of visitors in zoos), 'positive' (e.g., the behavioral response to the closure was positive, in that the animals were reportedly showing behaviors indicating that the lack of visitors in zoos had led to a more positive outcome for them), 'none' (if no change was reported), and 'unknown' (if the valence could not be determined from the information provided, e.g., "forgetting humans" or, as our focus was on reports of animal behavior during the closure periods, if the information did not relate to the current behavioral response to the facility closure and was instead a future prediction, e.g., "excited for reopening"). Due to the similarity in the terms used, we emphasize that the valence of animal reactions is the opposite of the 'effect' of visitors that is traditionally reported in the literature. For example, in this work, a 'negative' reaction from the animals suggests that the animals appear to have been negatively impacted by the lack of visitors in zoos, while 'positive' refers to animals showing behaviors indicating that the lack of visitors in zoos has reportedly led to a more positive outcome for them. An overview of examples of the search terms and their associated valence is provided in Table 3.

**Table 2.** Classification of Facebook posts and news reports, with reference to their anthropomorphic description, behavioral description, or a combination of both.

| Classification | Description | Example |
|---|---|---|
| Anthropomorphic | Attributes human emotions and motivations to non-human animals | "AMAZONIA IS REOPENING! Poppy the kinkajou and her friends at Amazonia have missed you" |
| Behavioral | Confined to a description of the behavior of the animals | "The animals are now showing more activity, have become more playful, and . . . their aggression levels have gone down" |
| Anthropomorphic/behavioral | Refers to the actions of the animals but attributes human motivation to the actions | "Our goats miss you! They've lined up by the gate to their home every morning since the Zoo closed, waiting patiently for visitors to return" |

### *2.2. Keeper Questionnaire*

The online questionnaire was created using Bristol Online Surveys (JISC) and was distributed to zookeepers via email to the International Congress of Zookeepers (ICZ) and social media platforms (Twitter, Facebook). The survey remained open for four months, from May to August 2021.

The questionnaire consisted of two parts and comprised both closed and open questions (Supplementary Materials). Part 1 was completed by all participants and contained two questions: the country of residence, and the size and type of zoo. Participants were then asked if they had worn face coverings when working with the animals prior to the COVID-19 pandemic. Depending on their answer, they were then directed to Part 2a (face coverings worn previously) or 2b (face coverings introduced in response to COVID-19 guidelines). Both versions of Part 2 asked for animal details (common name, sex and age), the duration of time in which the keeper had worked with that animal(s), the types of interactions that they usually had with the animal, and whether they believed that the animal(s) had displayed any behavioral changes since the COVID-19-related zoo closures. Keepers who had worn face masks prior to the COVID-19 pandemic were asked what type of face covering they wore, and the measures that they took when interacting with the animal to ensure efficient communication. Keepers who had introduced face coverings in response to the COVID-19 pandemic were asked to specify the point at which they introduced those face coverings, the type of face covering that they wore, whether they had noticed any changes in behavior when they first started wearing face coverings during

their interactions with the animals and whether they had taken any measures to enable efficient communication with the animals.

**Table 3.** Examples of the way in which search terms were used in the Facebook posts and news reports.

| Valence | Theme | Examples of Terms Used |
|---|---|---|
| Negative | Miss | "missing attention"; "missing visitors"; "sad not to see visitors", "as they miss interacting with human visitors" |
| | Lonely | "animals are becoming "lonely" without visitors", "Covid closures leave some animals lonely" |
| | Looking for | "looking for visitors" |
| | Bored | Needing more entertainment; less active, e.g., "restless" |
| | Stress | Signs of distress, e.g., "feather plucking"; depression, e.g., "morose"; "listless"; "apathetic" |
| | Keepers | Approaching keepers; increased interaction with keepers; requiring extra TLC from keepers |
| None | No change | "life as normal"; "still able to enjoy"; "oblivious" |
| Positive | Relaxed | "calmer"; "reduced aggression"; "reduced hiding"; "less elusive"; "increased resting in view"; "decreased vigilance"; "venturing out during the day"; terms relating to increased locomotory/exploratory behavior |
| | Mating | Increased mating; increased nesting |
| Unknown * | Forgetting | Forgetting "previous life"; forgetting humans |
| | Awareness of a difference | "aware of difference/change"; "confused" |
| | Excited | "excited for reopening"; "looking forward to reopening"; "can't wait until reopening" |
| | Unknown | No clear keyword/valence, e.g., "practicing speaking for visitor return"; "displaying to meerkat" |

* Terms were categorized as 'unknown' if the valence could not be determined from the information provided or, as our focus was on reports of animal behavior during the closure period, if the information did not relate to the current behavioral response to the facility closure and was, instead, a future prediction.

### *2.3. Data Analysis*

All data analysis was undertaken using IBM SPSS Statistics, Version 28.0.

#### 2.3.1. Social and National Media

A chi-square test with a Bonferroni-corrected post hoc test was undertaken to determine whether the responses to closures (e.g., positive response to the closure, negative response to the closure, or no change) reported on Facebook/in news reports were different from what would be expected by chance. A cross-tab chi-square with a Bonferroni-corrected post hoc test was undertaken to determine whether this differed across taxa and species orders. A cross-tab chi-square with a Bonferroni-corrected post hoc test was used to look at the relationship between the terminology used, defined as 'anthropogenic', 'behavioral', or using a combination of both anthropogenic and behavioral terminology, along with the taxa and orders that were identified. Spearman's rank correlation was used to determine the relationship between the number of responses to the posts and the comments on the Facebook posts. A Kruskal–Wallis test was used to look at the differences between the number of 'reactions' to Facebook posts and the number of comments, as well as which taxa were named in the post.

#### 2.3.2. Keeper Questionnaire

Data were analyzed using descriptive statistics, in order to understand keepers' perceptions of the animals' behavioral changes as a result of the COVID-19 closures and to capture the keepers' opinions of the animals' responses to their wearing face masks during keeper–animal interactions. The frequency with which positive or negative behavioral changes were reported by the keepers was assessed using a chi-square test. Comparisons

between data gathered via Facebook and news reports and the keepers' questionnaires will be made in the discussion below.

### 2.4. Ethics Statement

Research protocols for the keepers' questionnaires were approved by the Harper Adams University ethical review committee (project number: 0315-202103-STAFF).

## 3. Results

### 3.1. Social Media

In total, there were 229 relevant social media posts, made from 80 of the 122 BIAZA facilities' Facebook pages. The number of posts per facility ranged from 1 to 22 (mean ± SD, 3.2 ± 3.2). The modal number of posts per facility was 1. The number of reactions to the post ('like', 'love', etc.) ranged from 0 to 4775 (241 ± 464). The number of comments on each post ranged from 0 to 668 (25 ± 65). There was a significant positive correlation between the number of reactions to a post and the number of comments that a post received (Rs = 0.622, $p < 0.001$).

Six posts were made regarding unknown species, while 50 posts included the generic term 'animals'. In total, 196 posts concerned named species/species orders, which spanned 28 separate orders (Figure 1). The majority of posts referred to mammals (51% of posts, $n = 116$), followed by birds (26% of posts, $n = 59$). Reptiles were referred to in 7% of the posts ($n = 18$), and fish were referred to in 1% ($n = 3$). There was more variation in the reports of taxa than would be expected by chance ($X^2 = 156.449$, df = 3, $p < 0.001$). Mammals ($X^2 = 91.61$, $p < 0.0125$) were reported in Facebook posts more frequently than would be expected by chance. Reptiles ($X^2 = 19.61$, $p < 0.0125$) and fish ($X^2 = 43.18$, $p < 0.0125$) were reported less often than would be expected by chance. The frequency of reports regarding birds in the Facebook posts was no different from what would be expected by chance ($p > 0.0125$). There were no significant differences in the frequency of comments or responses across the different taxa ($p > 0.05$).

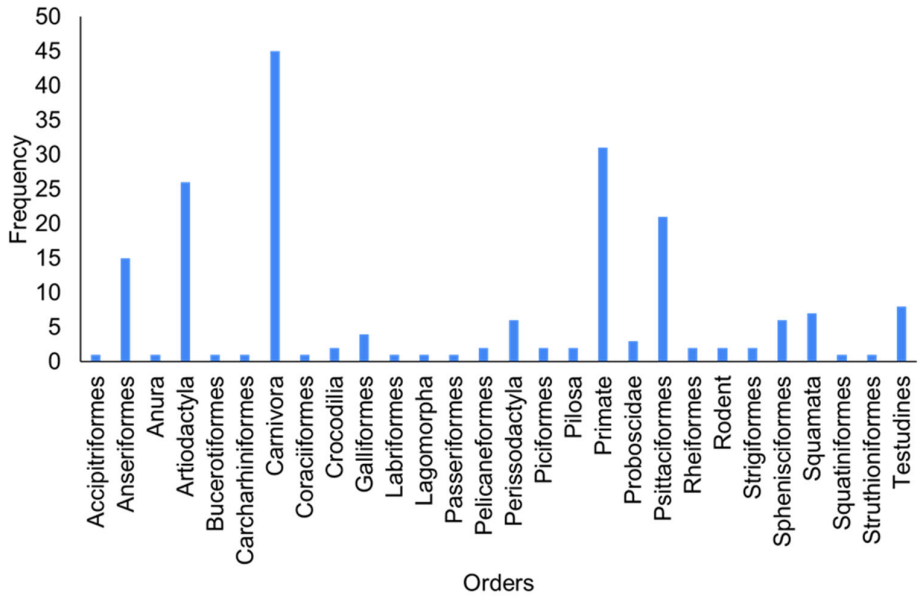


**Figure 1.** Overview of the frequency of orders being reported in BIAZA-accredited zoos' Facebook pages.

There were no significant differences in the number of responses or comments on Facebook posts in relation to species order ($p > 0.05$). The frequency with which orders were reported was significantly different from what would be expected by chance ($X^2 = 457.714$, df = 27, $p < 0.001$). The orders Anseriformes, Artiodactyla ($X^2 = 51.41$, $p < 0.002$), Carnivora ($X^2 = 205.62$, $p < 0.002$), Primates ($X^2 = 82.02$, $p < 0.002$) and Psittaci-

formes ($X^2$ = 27.91, $p < 0.002$) were reported more frequently than would be expected by chance. There was no significant difference in values according to chance for any of the other orders. There was no significant difference in the use of phrases in relation to behavioral responses (anthropogenic, a combination of anthropogenic and behavioral, and behavioral) across the orders ($p > 0.05$).

Behavioral changes reported by the zoos on social media were significantly different from what would be expected by chance ($X^2$ = 242.842, df = 2, $p < 0.001$). The behavioral changes reported were more frequently negative than would be expected by chance ($X^2$ = 163.82, $p < 0.02$) and were less frequently 'no change' ($X^2$ = 36.00, $p < 0.02$) or positive ($X^2$ = 46.24, $p < 0.02$). Taxa were not related to the types of behavioral changes reported ($p > 0.05$), but it was related to phrases used in relation to behavioral responses ($X^2$ = 20.977, df = 8, $p < 0.05$). Post hoc tests revealed that mammals were described, using a combination of both anthropogenic and behavioral terminology, more frequently than would be expected by chance ($X^2$ = 10.24, $p < 0.003$). There were no other significant differences from what would be expected by chance across taxa/terminology categories. When investigated at the level of orders, reported behavioral responses to the closures were different from what would be expected by chance ($X^2$ = 65.592, df = 38, $p < 0.05$); post hoc analyses revealed that this difference was in the Proboscidea, which showed lower than expected negative responses ($X^2$ = 26.01, $p < 0.0008$) and higher than expected behavioral indifference ($X^2$ = 16, $p < 0.0008$), and in the Pilosa, which showed higher than expected 'no change' responses ($X^2$ = 12.89, $p < 0.0008$). No other orders showed differences from what would be expected by chance ($p > 0.0008$).

### *3.2. News Reports*

In total, 75 separate news reports were analyzed. Within the 75 news reports, there were 273 separate animals from 17 countries and 51 named zoological facilities (60 from North American zoos, 60 from the UK, 35 from New Zealand and 33 from Indian zoos). Of these, 36 news reports were from a non-specified country and did not name a zoological collection. Animals were most frequently reported from ZSL London Zoo, UK ($n$ = 31), Orana Wildlife Park, New Zealand ($n$ = 23), Phoenix Zoo, US ($n$ = 19) and Delhi Zoo, India ($n$ = 12).

The 75 news reports were broken down into 303 relevant statements. The number of individual animals discussed in the whole article ranged from 1 to 47. The modal number of individual animals per report was 1, and the mean was 4. Six news reports were of unspecified species, referring to 'animals' ($n$ = 19 statements) and 'petting zoo animals' ($n$ = 1 statement). The minimum number of different taxa per news report was 1 and the maximum was 5. The modal number per news report was 1. The majority ($n$ = 282) of the 303 relevant statements referred to a particular species or taxon in the article. Mammals were most frequently highlighted in the reports (76% of statements). Birds (18%) and fish (5%) were also highlighted, but this was less frequent. Reptiles were only included twice in the reports, and invertebrates once. There was a significant variation from chance in the frequency of reported taxa ($X^2$ = 585.482, df = 4, $p < 0.001$). Statistically, mammals were over-represented ($X^2$ = 447.18, $p < 0.01$), while bird reports were as would be expected by chance ($p > 0.01$) and fish ($X^2$ = 31.96, $p < 0.01$), invertebrates ($X^2$ = 54.56, $p < 0.01$) and reptiles ($X^2$ = 52.61, $p < 0.01$) were under-represented.

Species/species orders were named in 274 statements, which spanned 23 separate orders (Figure 2). The frequency with which orders were reported was significantly different from what would be expected by chance ($X^2$ = 999.245, df = 22, $p < 0.001$). The orders Artiodactyla ($X^2$ = 37.40, $p < 0.002$), Carnivora ($X^2$ = 473.85, $p < 0.002$) and Primate ($X^2$ = 345.21, $p < 0.002$) were reported more frequently than would be expected by chance. The orders Accipitriformes ($X^2$ = 9.98, $p < 0.002$), Casuariiformes ($X^2$ = 9.98, $p < 0.002$), Columbiformes ($X^2$ = 9.98, $p < 0.002$), Crocodilia ($X^2$ = 9.98, $p < 0.002$), Phoenicopteriformes ($X^2$ = 9.98, $p < 0.02$) and Rodentia ($X^2$ = 9.98, $p < 0.002$) were reported less frequently than

would be expected by chance. The number of reports of all other orders was no different than would be expected by chance ($p > 0.002$).

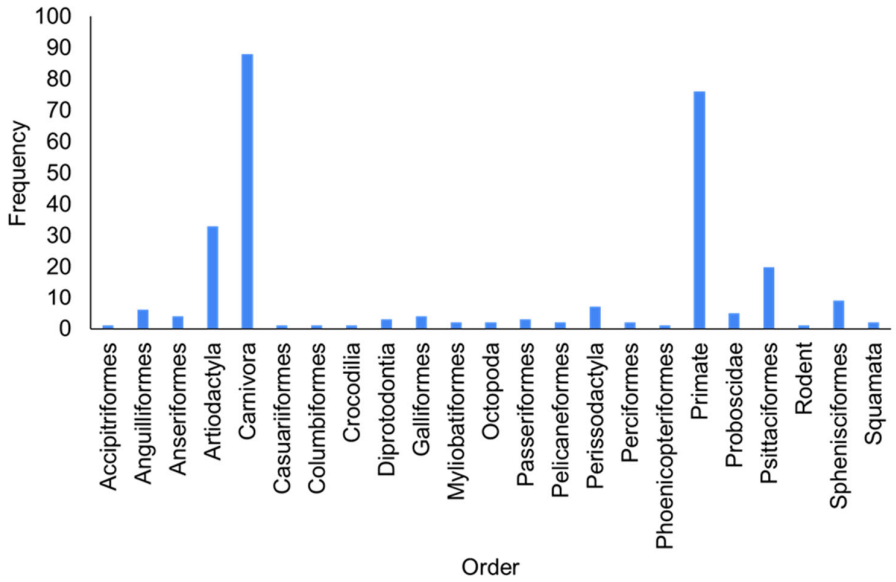


**Figure 2.** Overview of the frequency of orders highlighted in news reports.

Positive or negative behavioral responses to the closures were reported in 224 statements. The majority of reports were of negative behavioral responses in the animals (62% of statements). Positive responses were reported in 20% of statements, and in 9% of statements, there were no behavioral changes observed. In 9% of the statements, there was not enough information for an assessment to be made in relation to whether the responses were positive, negative, or showed no change. Positive impacts included the keywords 'mating' (7%) and 'relaxed' (20%). Negative impacts included the keywords 'miss' (36%), 'lonely' (3%), 'looking for' (6%), 'bored' (5%) and 'stress' (4%). The majority of statements involved a combination of anthropomorphic and behavioral terms (38%) or were solely anthropomorphic (35%). Purely behavioral reports occurred in 27% of the statements.

Overall, there was a significant change from what would be expected by chance in the reported animal responses to the closure periods ($X^2 = 160.70$, df = 4, $p < 0.001$). Positive changes in animals as a result of the closures were less frequently reported than would be expected by chance ($X^2 = 11.11$, $p < 0.02$), while negative changes were more than expected by chance ($X^2 = 101.16$, $p < 0.02$) and no behavioral change was reported less frequently than expected by chance ($X^2 = 45.89$, $p < 0.02$). When this finding was compared across taxa, there was a significant difference from what would have been expected by chance ($X^2 = 17.288$, df = 8, $p < 0.05$). However, pairwise comparisons using Bonferroni corrections did not reveal significant differences between the categories ($p > 0.003$).

In 24 statements, which included eight orders, behavioral changes were unknown. Where a behavioral change was reported (either no change, positive or negative) there was a significant difference across the orders ($X^2 = 72.498$, df = 38, $p < 0.001$). Reports of Carnivora indicated greater indifference (no change) than was expected by chance ($X^2 = 15.21$, $p < 0.0008$) and lower than expected negative responses ($X^2 = 12.96$, $p < 0.0008$), while reports of primates showed higher than expected negative responses ($X^2 = 10.89$, $p < 0.0008$). No other orders showed significant differences within the reports ($p > 0.008$).

The types of language used in the news reports differed across the different orders ($X^2 = 118.019$, df = 44, $p < 0.001$). In posts on the order Carnivora, behavioral descriptors were used more frequently than was expected by chance ($X^2 = 26.01$, $p < 0.007$), while anthropogenic descriptions were lower in frequency than would be expected by chance ($X^2 = 12.25$, $p < 0.007$). Behavioral changes in primates were reported using anthropogenic terminology more often than was expected by chance ($X^2 = 31.36$, $p < 0.007$), with behavioral terminology

only being used less often than expected by chance ($X^2 = 16.81$, $p < 0.007$). No significant differences were reported in the frequency of combined anthropogenic/behavioral reports ($p > 0.007$).

### 3.3. Keeper Questionnaires

The questionnaire was completed by 40 respondents. The majority of these respondents were from the UK ($n = 25$) and the USA ($n = 6$). Other respondents were from mainland Europe ($n = 4$), Australia ($n = 3$), Africa ($n = 1$) and South Africa ($n = 1$). The type of facility in which the respondents worked varied, with the majority being from zoos ($n = 28$). However, there were also representatives from drive-through safaris ($n = 5$), sanctuaries ($n = 3$), aquariums ($n = 2$), bird of prey centers ($n = 2$), wildlife parks ($n = 1$) and farm parks ($n = 1$).

#### 3.3.1. Behavioral Changes in Relation to Facility Closures

Behavioral changes as a result of the COVID-19 closures, in general, were reported by 19 respondents, while a further 19 respondents reported no change and two were unsure of whether any changes had occurred. A breakdown of the behavioral changes reported by survey respondents is given in Table 4. Three were related specifically to the presence of people (e.g., seeking interactions with keepers and looking out for visitors). Five respondents reported changes in behavior; these were both positive (e.g., increased social play, more relaxed behavior, using more of the enclosure and 'enjoying freedom') and negative (e.g., increased aggression/frustration, increased stereotypical behavior/anticipation of events).

**Table 4.** A summary of animal behavioral responses, as reported by survey respondents.

| Behavioral Change Reported | Identified Valence | Frequency Reported |
|---|---|---|
| Increased foraging | Positive | 1 |
| Increased social play | | 2 |
| Using more of the enclosure/using different parts of the enclosure | | 2 |
| More relaxed | | 4 |
| Fewer interactions with humans | | 1 |
| Deterioration in training | Negative | 1 |
| Looking out for people/training sessions | | 3 |
| More quiet/withdrawn | | 2 |
| Startling easily | | 1 |
| Wary of new people/staff in new face masks | | 2 |
| Increased aggression | | 2 |
| Seeking interactions with keepers/showing increased interest in keepers | | 4 |
| Increased stereotypical/anticipatory behavior | | 2 |
| More inclined to grab food items | | 1 |
| Increased vocalisations | | 1 |
| Less interactivity/reduced activity | | 2 |

#### 3.3.2. Animal Behavioral Changes in Relation to Keeper Interactions

The majority of respondents ($n = 38$) did not wear face masks when interacting with their animals prior to the pandemic. Of those, 18 respondents reported behavioral changes since wearing face masks and 20 reported no changes. A breakdown of the reported behavioral changes is given in Table 5. The main behavioral change reported was increased hesitancy/wariness and a tendency to startle more easily than before the closures. One keeper reported that the nervousness in the species they worked with reduced after approximately one month of closure, with the animal displaying differing responses to face mask designs/patterns.

**Table 5.** An overview of the behavioral changes reported by keepers during keeper–animal interactions when wearing face coverings.

| Behavior Change | Frequency Reported |
|---|---|
| Increased vocalization | 2 |
| Stealing masks | 1 |
| Struggling to recognize staff | 2 |
| Not interacting in the same way | 1 |
| Interest/curiosity in the mask | 5 |
| More hesitant/wary/startling easily | 12 |
| Aggression toward the keeper | 1 |

The majority of keepers ($n$ = 29) did not report making changes to their own behavior to ensure effective communication between themselves and the animals when wearing face masks. One keeper said that their animals had habituated to them wearing face coverings within a few days. Nine keepers reported making modifications to their own behavior, the most common of which was talking more to the animals when they entered enclosures ($n$ = 4) and making modifications to training (e.g., using hand signals and changing to a verbal bridge for commands, $n$ = 3). Other modifications included having a period without a face mask or lowering the face covering, to enable the animal to see the keeper prior to the interaction/training ($n$ = 2), showing the face covering to the animal ($n$ = 1) and increasing the distance from the animal ($n$ = 1). The two facilities that routinely wore face masks when interacting with their animals reported making efforts to improve communication with animals, including the use of hand signals and using colored buckets to communicate when it was feeding time.

## 4. Discussion

### *4.1. Behavioral Changes during Facility Closures*

There was a combination of responses that were reported across social media (Facebook), in national/international media and in the keeper reports. Animal responses included responding negatively to the closures/lack of visitors (e.g., missing the public, startling easily, becoming more withdrawn), responding positively (e.g., using more of the enclosure, being more relaxed) or presenting neutral responses (e.g., showing no behavioral changes). In England, one zoo reported on Facebook that some of their animals were settling down earlier at night while there were no visitors in the zoo; "*Animal pictures today are Rhea and Mara, both from the South American Pampas, both photographed tonight when, yet again, they were turning in early, in common with most of our animals at the moment. Without visitors in, they are all settling down earlier at night*" and a zoo in India reported positive behavioral changes in their big cats, stating that "*the animals are now showing more activity, have become more playful, and their aggression levels have gone down*". Other animals had much more overtly negative responses to the closures, with one US zoo reporting that their gray cockatoo had become "*so distressed at his new-found solitude that he began self-harming, plucking his chest feathers until he gnawed a hole in his skin that had to be covered with a vest*". As we predicted, across all the different settings, reported behavioral responses from the animals during the closures were more frequently negative than would be expected by chance and were less frequently positive or neutral responses. The mixed behavioral responses that were reported mirrored findings published in the human–animal interaction literature under 'normal' zoo operations. The overarching reports of negative responses to the absence of zoo visitors highlighted the importance of zoo visitors to the lives of a number of zoo animals, and, thus, advocated for the reopening of facilities in order to facilitate enrichment opportunities for the animals.

Visitors provide three types of stimuli to zoo animals: visual, olfactory and auditory [58]. Visitors have been identified as a source of noise pollution in zoos, with zoos that have no visitors being reported as being significantly quieter than during open periods [59]. Animals may be negatively impacted by variable and/or unpredictable noises, whereas

they will be less affected by constant and stable background noises [60,61], such as those provided by the presence of visitors within a facility. During this study, it was noted that the lack of visitors and the associated ambient noise was heightening the sensitivity of some species to other animals in the zoo. For example, one newspaper report quoted an Indian zoo as saying "*I feel that it is the spotted deer population that have been showing high alerts these days. With no noise around, the roaring of the lions and tigers is being heard louder, which is scaring them*". Consideration of animal enclosure placement within zoos is paramount for the good welfare of all zoo species, both in terms of the presence of predators near prey animals [62] and also in relation to vocalizations and the associated auditory pollution caused by particularly vocal species [63]. It may, thus, be the case that visitors are more than just a visually enriching stimulus at enclosure windows; rather, their presence may supply steady background noise that helps to reduce the impact of some of the other potential stressors experienced by animals in zoos.

### *4.2. Behavioral Changes during Keeper-Animal Interactions*

General behavioral changes occurring during the COVID-19 closures were reported on social media, in national media outlets, and via keeper reports. However, there were also behavioral changes specifically reported during keeper-animal interactions, which may have been due to the zoo closures themselves and to an associated awareness in the animals, or it may have been as a result of the introduction of face masks during keeper–animal interactions. A large proportion of the surveyed keepers (67%) who reported behavioral changes in their animals during interactions once they had started wearing face masks, reported their animals being more hesitant/wary or startling easily during these interactions. This is an important factor to be considered in terms of the impact of face coverings and subsequent alterations in communication on human–animal interactions. Face masks hinder human–human communication by eliminating the role of the middle and lower face in the expression of emotions; during the pandemic, they caused difficulty in understanding facial expressions during conversations and decreased the impact of communication [64]. Many animals communicate via facial expressions, and the introduction of face masks for keepers when they are working/interacting with animals and for members of the public when they are viewing zoo animals may have ramifications for human–animal communication and animal experiences of the interaction. Wearing face masks has affected the ability of humans to recognize emotions in others [65]; likewise, reports of wild Eurasian tree sparrows indicated reduced fear responses to humans wearing face masks [54]. Although communication between keepers and animals may have been hampered by the regulations concerning mask-wearing, there could be some positive sides to the public wearing face masks within zoological facilities for some species. Reducing direct visual contact between visitors and zoo primates has been shown to reduce aggression, abnormal behavior and excessive vigilance [28,66,67]. Humans communicate positive emotions via smiling, which carries the reverse meaning of the smiling gesture in non-human primates [68]. The covering of the majority of the face and the interruption of negatively perceived gestures that are accidentally received from members of the public could have positive implications for primates in zoos, although it was beyond the scope of this study to formally undertake this assessment.

### *4.3. Taxa Bias*

Published animal welfare research within zoos is biased toward mammals, with great apes being the dominant taxa [56], despite significantly more birds and fish being kept in collections than mammals, reptiles and amphibians [69]. The majority of these well-studied species are charismatic and high-profile [55]. Mammals were more highly represented than any other species in both Facebook posts and news reports during this study. This representation was particularly skewed in news reports (46% of Facebook posts concerned mammals; in news reports, 76% of statements concerned mammals). Within the Facebook posts, birds were represented in 26% of posts, despite them being identified as an under-

represented taxon in animal welfare research [69] and the previously reported lack of interest in birds within facilities (identified via the proportion of visitors stopping at an enclosure and visitor dwell time; [70]). The classification of birds as higher vertebrates may be the reason for the greater frequency of reports of birds in the social and national media, despite their greater evolutionary divergence from humans.

### *4.4. Anthropomorphism and Empathy for Animals*

Empathy for animals leads to pro-environmental behavior changes, environmental self-efficacy, the intent to take conservation action [17] and actual engagement in conservation behavior [71]. Empathy for species is negatively related to evolutionary divergence [72]. Anthropomorphism has been identified as a useful tool for building empathy with animals, promoting conservation behavior [18] and encouraging support for wildlife conservation work, particularly regarding trying to overcome the detrimental effect of the COVID-19 pandemic [73]. Anthropomorphism is more likely to be used by individuals when animals are phylogenetically [57], morphologically or behaviorally more similar to humans [14]. It is thus more likely that mammalian species, in particular, primates, would be anthropomorphized by members of the public, evoking greater empathy for the plight of those species. The use of anthropomorphism observed during this study in relation to the various taxa and orders differed between Facebook posts and news reports. On the Facebook pages of BIAZA-accredited zoos, mammals had a combination of behavioral descriptions and anthropomorphic terms, used more frequently than might be expected by chance. Conversely, in the news reports of primate species, anthropomorphic descriptions were more frequent than was expected by chance, and behavioral descriptions were less frequent than expected by chance. Reports of the Carnivora were the reverse of this, with behavioral reports being more frequent than expected by chance and anthropomorphic descriptions being less frequent than expected by chance.

### *4.5. Zoo Communication with the Public*

The temporary closure of zoos, and the financial challenges stemming from this necessity, meant that zoo staff needed to employ novel methods of communication with the public throughout the pandemic [7]. Innovative ways employed by zoos to engage the public included a Japanese zoo video calling the garden eels [74] and the posting of videos of keepers taking animals for walks around the zoo [75]. These had the dual benefit of raising their profile and encouraging support from the public, providing a continued source of entertainment and support from the public and offering positive stories at a time when many people were struggling with the impact of the pandemic [76]. With billions of users, social media offers lucrative opportunities to engage with customers around the world [77].

Within zoos, social media is a popular means of sharing information with a wide range of audiences and connecting with members of the public. However, posting content impacts the likelihood of engagement with visitors, with overtly conservation- or education-based posts attracting little interest [9]. Engagement with the social media posts was high, with an average of 241 reactions to each Facebook post and an average of 25 comments. Reactions to posts and comments on posts were significantly correlated, which suggests that posts were attracting attention, both in terms of reactions and comments on the social media platforms; thus, the aim of engaging with the public was achieved.

The various media platforms and methods of communication appeal to different demographics. By taking a two-pronged approach and using both social and news media sites, zoos are broadening their reach in terms of their connectivity with the general public. The slightly different use of terminology (particularly in terms of the anthropomorphism of species) may also reflect the job position of the person making the post. It is likely that individuals posting on Facebook pages, who were based at British and Irish zoos, may hold different positions within the organizations than those responsible for press releases to the national/international media. For example, during zoo closures, many social media sites were being operated by the keepers or were including content provided by keepers

(e.g., video tours of the zoo, taking animals for tours around the zoo). Conversely, it is likely that news reports will have been organized by press departments, with input from non-zoo-based journalists and outside personnel. Those with journalistic training may, therefore, have been more likely to employ anthropomorphic terms to increase empathy and to engage readers, encouraging engagement and interest in the story and, consequently, the likelihood of support for their cause.

### *4.6. Study Limitations and Areas for Future Research*

The two main limitations of this piece of research are related to the gathering of information in relation to news reports and keepers' perceptions of animal behavior during the COVID-19 period. Google searches are not reproducible, and caution has been urged when using them for primary review searches during systematic reviews [78]; however, they are considered suitable as a supplementary source and for capturing grey literature [79]. The aim of this work was to capture material that was available to the general public; thus, although the limitations of slightly different outputs are recognized, Google was considered suitable as a source for capturing information disseminated to the general public during the COVID-19 pandemic. The requirement for the articles to be written in English to avoid the inaccuracies associated with automatic translating services meant that there was a bias toward English-speaking media. Consequently, the results presented here are not necessarily representative of a global picture. However, as with the accuracy of Google searches, they do represent material that was readily available to the English-speaking/reading public, thus capturing articles that are relevant to the audience demographic. The search terms that were used may also have led to an over-representation of negative responses in the Google and Facebook searches, due to the absence of overtly positive search terms. However, neutral search terms generally related to the pandemic were included (e.g., coronavirus, COVID-19), as well as terms related to zoos (e.g., zoos, visitors), and all articles/social media posts that had a search term within them were included in the results; therefore, the positive impacts of the pandemic could still be captured using this methodology.

The keepers' questionnaire was distributed approximately 12 months after the COVID-19 pandemic began and the associated zoo closures occurred. This may have led to memory changes by the keepers as to the exact responses of animals. This limitation is considered relatively minor, as the data here were used only to look at the degree to which the keepers' reports matched with the Facebook/news reports; thus, just a 'general idea' of behavioral changes offered an adequate degree of accuracy. Furthermore, some keepers separated out initial responses from longer-term responses, which suggests that they had seen clearly differentiated short- and long-term changes, despite the long period of time. The uniqueness of the situation likely also led to clearer memories forming, in spite of the lapse of time between the pandemic beginning and the questionnaire. Finally, within the UK, the wearing of face masks was still recommended under temporary government legislation, so the response of animals to the masks during keeper–animal interactions was still current at the time of the study. It is also important to highlight that the sample size for the keeper questionnaire was relatively small ($n$ = 40) and, thus, may not be representative of the experience of the wider zookeeping population. They do, however, highlight some of the responses observed by the keepers who did complete the survey, and they are representative of some of the techniques that those keepers undertook to overcome those difficulties.

Analysis of data collected via social media has been identified as a useful means of understanding public knowledge and their perceptions of science-related issues, which, in turn, is useful for predicting behavioral change [80]. Social media has been identified as a useful means of communication within zoos, offering the opportunity to actively engage the public with the full range of modern zoo missions [9]. The qualitative approach that was undertaken here captured the manner in which zoological facilities were reporting the impact of the COVID-19 closures on zoo animals to the general public. Further research that considers the way in which zoos communicate with the general public outside of

exceptional circumstances (such as those reported here) is advocated, with a particular focus on the relationship between the anthropomorphism of different taxa and the associated audience engagement. Consideration should also be given to a wider range of social media channels, to capture communication with the full potential audience, including younger adults.

## 5. Conclusions

The aim of this work was to capture the impact of COVID-19-enforced closures of zoological facilities on animal behavior. More specifically, it was to capture how this impact was communicated to the general public, via Facebook and national/international media channels, and to what degree this mirrored the reports by keepers who were working with the animals throughout the pandemic. Mammals were over-represented in both Facebook posts and news reports, a finding concurrent with other literature on this topic. Behavioral responses to the closures were more frequently negative than would be expected by chance and were less frequently positive or neutral. It is likely that the role of visitors is multi-faceted, and that the sudden closures led to a lack of stimulation from visitors for some species and a lack of sound buffering/distraction for others. For some species, however, the closures may have given them an opportunity to experience an environment where they could behave more naturally and use more of their enclosures. This highlights the variability of animal responses to visitors that is reported in other studies and supports the need for enclosure designs that consider individual animals' needs. Keepers also reported changes in animal responses to the use of face masks in their interactions, which suggests that similar difficulties in communication were occurring between keepers and animals as were reported by the general public. The language used to discuss the animals' responses to the closures varied across taxa and also across media types. On Facebook, mammals were discussed with a combination of behavioral descriptions and anthropomorphic terms that were used more frequently than was expected by chance. In the news reports, anthropomorphic descriptions of primates were more frequent than expected by chance, and behavioral descriptions were less frequent than expected by chance. Reports on Carnivora showed the reverse of this, with anthropomorphic descriptions being lower in frequency than expected by chance and behavioral descriptions being more frequent than was expected merely by chance. These findings may reflect the relationship that humans have with different animals and the requirement for communication methods that capture visitor interest and induce empathy with species. Further research that considers zoo communication with the general public outside of exceptional circumstances (such as those reported here) is advocated, with a particular focus on the relationship between the anthropomorphism of different taxa and associated audience engagement.

**Supplementary Materials:** The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/jzbg3020022/s1, Keeper questionnaire.

**Author Contributions:** Conceptualization, V.H., J.R., A.C. and E.W.; methodology, V.H., J.R., A.C. and E.W.; formal analysis, E.W.; data curation, V.H.; writing—original draft preparation, V.H., J.R., A.C. and E.W.; writing—review and editing, V.H., J.R., A.C. and E.W.; project administration, V.H. and E.W. All authors have read and agreed to the published version of the manuscript.

**Funding:** This research received no external funding.

**Institutional Review Board Statement:** Research protocols for the keeper questionnaire were approved by the Harper Adams University ethical review committee (project number 0315-202103-STAFF).

**Informed Consent Statement:** Informed consent was obtained from all subjects involved in the study.

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

**Acknowledgments:** The research team wishes to offer their sincere thanks to the International Congress of Zoo Keepers for their support of this work, and to the anonymous keepers who very kindly took the time to complete the questionnaire. This helped to add an extra dimension to this

piece of work, and we are very grateful for your time and input. Special thanks are also extended to Samantha J. Ward, who helped with the design of the zookeepers' questionnaire and offered comments on an earlier version of this manuscript.

**Conflicts of Interest:** The authors declare no conflict of interest.

## References

1. Sherwen, S.L.; Hemsworth, P.H. The Visitor Effect on Zoo Animals: Implications and Opportunities for Zoo Animal Welfare. *Animals* **2019**, *9*, 366. [CrossRef] [PubMed]
2. Riley, A.; Terry, M.; Freeman, H.; Alba, A.C.; Soltis, J.; Leeds, A. Evaluating the Effect of Visitor Presence on Nile Crocodile (*Crocodylus niloticus*) Behavior. *J. Zool. Bot. Gard.* **2021**, *2*, 115–129. [CrossRef]
3. World's Leading Zoos and Aquariums (WAZA). Available online: https://www.waza.org/ (accessed on 2 April 2022).
4. Statista Number of Visits to the Chester Zoo in the UK 2010–2021. Available online: https://www.statista.com/statistics/586785/chester-zoo-visitor-numbers-united-kingdom-uk/ (accessed on 11 April 2022).
5. BBC Coronavirus: Living Coasts Zoo to Close Due to Lockdown. Available online: https://www.bbc.co.uk/news/uk-england-devon-53052526 (accessed on 28 March 2022).
6. Tang, T. 'Outside the Box': Zoos Turn to Social Media to Delight, Raise Money Amid Coronavirus. Available online: https://eu.usatoday.com/story/travel/news/2020/05/05/coronavirus-zoos-turn-social-media-delight-raise-money/3083512001/ (accessed on 11 April 2022).
7. Fine, L.; Barnes, C.; Niedbalski, A.; Deem, S.L. Staff Perceptions of COVID-19 Impacts on Wildlife Conservation at a Zoological Institution. *Zoo Biol.* **2022**, *41*, 234–243. [CrossRef] [PubMed]
8. Ryder, B.; Zhang, T.; Hua, N. The Social Media "Magic": Virtually Engaging Visitors during COVID-19 Temporary Closures. *Adm. Sci.* **2021**, *11*, 53. [CrossRef]
9. Rose, P.E.; Hunt, K.A.; Riley, L.M. Animals in an Online World; an Evaluation of How Zoological Collections Use Social Media: Social Media in Zoos. *J. Zoo Aquar. Res.* **2018**, *6*, 57–62. [CrossRef]
10. British and Irish Association of Zoos and Aquariums (BIAZA). COVID-19 Member Update–07/07/20. Available online: https://biaza.org.uk/downloader/1792 (accessed on 23 March 2022).
11. Williams, E.; Rendle, J. How Captive Animals Are Coping with the Sudden Emptiness of the World's Zoos and Aquariums. *The Conversation*, 18 May 2020.
12. Hooper, J.; Aiello, T.; Hill, K. Portrayals of Animals in COVID-19 News Media. *Anthrozoös* **2022**, *35*, 237–257. [CrossRef]
13. Chan, A.A.Y.-H. Anthropomorphism as a Conservation Tool. *Biodivers Conserv.* **2012**, *21*, 1889–1892. [CrossRef]
14. Urquiza-Haas, E.G.; Kotrschal, K. The Mind behind Anthropomorphic Thinking: Attribution of Mental States to Other Species. *Anim. Behav.* **2015**, *109*, 167–176. [CrossRef]
15. Fischer, J. Disambiguating Anthropomorphism: An Interdisciplinary Review. *Perspect. Ethol.* **1991**, *9*, 49–85.
16. Beres, J. Using Social Media and Anthropomorphism to Engage Zoo Visitors with Uncharismatic and Unpopular Species. *Int. Zoo Educ. Assoc. J.* **2019**, *55*, 8–11.
17. Johnson, L. Exploring the Relationship between Empathy for Animals and Environmental Self-Efficacy in Zoo and Aquarium Visitors. Master's Thesis, University of Washington, Seattle, WA, USA, 2020.
18. Young, A.; Khalil, K.A.; Wharton, J. Empathy for Animals: A Review of the Existing Literature. *Curator* **2018**, *61*, 327–343. [CrossRef]
19. Bloomfield, R.C.; Gillespie, G.R.; Kerswell, K.J.; Butler, K.L.; Hemsworth, P.H. Effect of Partial Covering of the Visitor Viewing Area Window on Positioning and Orientation of Zoo Orangutans: A Preference Test. *Zoo Biol.* **2015**, *34*, 223–229. [CrossRef] [PubMed]
20. Davey, G. Visitors' Effects on the Welfare of Animals in the Zoo: A Review. *J. Appl. Anim. Welf. Sci.* **2007**, *10*, 169–183. [CrossRef] [PubMed]
21. Claxton, A.M. The Potential of the Human–Animal Relationship as an Environmental Enrichment for the Welfare of Zoo-Housed Animals. *Appl. Anim. Behav. Sci.* **2011**, *133*, 1–10. [CrossRef]
22. Hosey, G.R. Zoo Animals and Their Human Audiences: What Is the Visitor Effect? *Anim. Welf.* **2000**, *9*, 343–357.
23. Hosey, G.R. How Does the Zoo Environment Affect the Behaviour of Captive Primates? *Appl. Anim. Behav. Sci.* **2005**, *90*, 107–129. [CrossRef]
24. Nimon, A.J.; Dalziel, F.R. Cross-Species Interaction and Communication: A Study Method Applied to Captive Siamang (Hylobates Syndactylus) and Long-Billed Corella (*Cacatua tenuirostris*) Contacts with Humans. *Appl. Anim. Behav. Sci.* **1992**, *33*, 261–272. [CrossRef]
25. Davis, N.; Schaffner, C.M.; Smith, T.E. Evidence That Zoo Visitors Influence HPA Activity in Spider Monkeys (Ateles Geoffroyii Rufiventris). *Appl. Anim. Behav. Sci.* **2005**, *90*, 131–141. [CrossRef]
26. Collins, C.; Marples, N. The Effects of Zoo Visitors on a Group of Western Lowland Gorillas (*Gorilla gorilla gorilla*) before and after the Birth of an Infant at Dublin Zoo. *Int. Zoo Yearb.* **2016**, *50*, 183–192. [CrossRef]
27. Birke, L. Effects of Browse, Human Visitors and Noise on the Behaviour of Captive Orang Utans. *Anim. Welf.* **2002**, *11*, 189–202.

28. Blaney, E.; Wells, D. The Influence of a Camouflage Net Barrier on the Behaviour, Welfare and Public Perceptions of Zoo-Housed Gorillas. *Anim. Welf.* **2004**, *13*, 111–118.
29. Sherwen, S.L.; Magrath, M.J.L.; Butler, K.L.; Phillips, C.J.C.; Hemsworth, P.H. A Multi-Enclosure Study Investigating the Behavioural Response of Meerkats to Zoo Visitors. *Appl. Anim. Behav. Sci.* **2014**, *156*, 70–77. [CrossRef]
30. Margulis, S.W.; Hoyos, C.; Anderson, M. Effect of Felid Activity on Zoo Visitor Interest. *Zoo Biol.* **2003**, *22*, 587–599. [CrossRef]
31. O'Donovan, D.; Hindle, J.E.; McKeown, S.; O'Donovan, S. Effect of Visitors on the Behaviour of Female Cheetahs *Acinonyx jubutus* and Cubs. *Int. Zoo Yearb.* **2007**, *32*, 238–244. [CrossRef]
32. Williams, E.; Carter, A.; Rendle, J.; Ward, S.J. Understanding Impacts of Zoo Visitors: Quantifying Behavioural Changes of Two Popular Zoo Species during COVID-19 Closures. *Appl. Anim. Behav. Sci.* **2021**, *236*, 105253. [CrossRef]
33. Fink, L.B.; Scarlata, C.D.; VanBeek, B.; Bodner, T.E.; Wielebnowski, N.C. Applying Behavioral and Physiological Measures to Assess the Relative Impact of the Prolonged COVID-19 Pandemic Closure on Two Mammal Species at the Oregon Zoo: Cheetah (*A. jubatus*) and Giraffe (*G. c. reticulata* and *G. c. tippelskirchii*). *Animals* **2021**, *11*, 3526. [CrossRef] [PubMed]
34. Williams, E.; Carter, A.; Rendle, J.; Ward, S.J. Impacts of COVID-19 on Animals in Zoos: A Longitudinal Multi-Species Analysis. *J. Zool. Bot. Gard.* **2021**, *2*, 10. [CrossRef]
35. Jones, M.; Gartland, K.; Fuller, G. Effects of Visitor Presence and Crowd Size on Zoo-Housed Red Kangaroos (Macropus Rufus) during and after a COVID-19 Closure. *Anim. Behav. Cogn.* **2021**, *8*, 521–537. [CrossRef]
36. Boultwood, J.; O'Brien, M.; Rose, P. Bold Frogs or Shy Toads? How Did the COVID-19 Closure of Zoological Organisations Affect Amphibian Activity? *Animals* **2021**, *11*, 1982. [CrossRef]
37. Kidd, P.; Ford, S.; Rose, P.E. Exploring the Effect of the COVID-19 Zoo Closure Period on Flamingo Behaviour and Enclosure Use at Two Institutions. *Birds* **2022**, *3*, 117–137. [CrossRef]
38. World Health Organisation. WHO Coronavirus Disease (COVID-19) Dashboard. Available online: https://covid19.who.int (accessed on 30 December 2020).
39. Huber, L.; Racca, A.; Scaf, B.; Virányi, Z.; Range, F. Discrimination of Familiar Human Faces in Dogs (*Canis familiaris*). *Learn. Motiv.* **2013**, *44*, 258–269. [CrossRef] [PubMed]
40. Rybarczyk, P.; Koba, Y.; Rushen, J.; Tanida, H.; de Passillé, A.M. Can Cows Discriminate People by Their Faces? *Appl. Anim. Behav. Sci.* **2001**, *74*, 175–189. [CrossRef]
41. Kendrick, K.M.; Atkins, K.; Hinton, M.R.; Broad, K.D.; Fabre-Nys, C.; Keverne, B. Facial and Vocal Discrimination in Sheep. *Anim. Behav.* **1995**, *49*, 1665–1676. [CrossRef]
42. Stone, S.M. Human Facial Discrimination in Horses: Can They Tell Us Apart? *Anim. Cogn.* **2010**, *13*, 51–61. [CrossRef] [PubMed]
43. Ghirlanda, S.; Jansson, L.; Enquist, M. Chickens Prefer Beautiful Humans. *Hum. Nat.* **2002**, *13*, 383–389. [CrossRef]
44. Stephan, C.; Wilkinson, A.; Huber, L. Have We Met Before? Pigeons Recognise Familiar Human Faces. *Avian. Biol. Res.* **2012**, *5*, 75–80. [CrossRef]
45. Dyer, A.G.; Neumeyer, C.; Chittka, L. Honeybee (*Apis mellifera*) Vision Can Discriminate between and Recognise Images of Human Faces. *J. Exp. Biol.* **2005**, *208*, 4709–4714. [CrossRef]
46. Newport, C.; Wallis, G.; Reshitnyk, Y.; Siebeck, U.E. Discrimination of Human Faces by Archerfish (*Toxotes chatareus*). *Sci. Rep.* **2016**, *6*, 27523. [CrossRef]
47. Mitchell, G.; Obradovich, S.D.; Herring, F.H.; Dowd, B.; Tromborg, C. Threats to Observers, Keepers, Visitors, and Others by Zoo Mangabeys (*Cercocebus galeritus chrysogaster*). *Primates* **1991**, *32*, 515–522. [CrossRef]
48. Melfi, V.A.; Thomas, S. Can Training Zoo-Housed Primates Compromise Their Conservation? A Case Study Using Abyssinian Colobus Monkeys (*Colobus guereza*). *Anthrozoös* **2005**, *18*, 304–317. [CrossRef]
49. Ward, S.J.; Melfi, V. Keeper-Animal Interactions: Differences between the Behaviour of Zoo Animals Affect Stockmanship. *PLoS ONE* **2015**, *10*, e0140237. [CrossRef] [PubMed]
50. Sinnott, J.M.; Speaker, H.A.; Powell, L.A.; Mosteller, K.W. Perception of Scary Halloween Masks by Zoo Animals and Humans. *Int. J. Comp. Psychol.* **2012**, *25*, 83–96.
51. Nawroth, C.; Albuquerque, N.; Savalli, C.; Single, M.-S.; McElligott, A.G. Goats Prefer Positive Human Emotional Facial Expressions. *R. Soc. Open Sci.* **2018**, *5*, 180491. [CrossRef] [PubMed]
52. Proops, L.; Grounds, K.; Smith, A.V.; McComb, K. Animals Remember Previous Facial Expressions That Specific Humans Have Exhibited. *Curr. Biol.* **2018**, *28*, 1428–1432.e4. [CrossRef]
53. Yosef, R.; Hershko, M.; Zduniak, P. Anti COVID-19 Face-Masks Increases Vigilance in Nubian Ibex (*Capra nubiana*). *Biol. Conserv.* **2021**, *263*, 109339. [CrossRef]
54. Jiang, X.; Liu, J.; Zhang, C.; Liang, W. Face Masks Matter: Eurasian Tree Sparrows Show Reduced Fear Responses to People Wearing Face Masks during the COVID-19 Pandemic. *Glob. Ecol. Conserv.* **2020**, *24*, e01277. [CrossRef] [PubMed]
55. Melfi, V. There Are Big Gaps in Our Knowledge, and Thus Approach, to Zoo Animal Welfare: A Case for Evidence-based Zoo Animal Management. *Zoo Biol.* **2009**, *28*, 574–588. [CrossRef]
56. Binding, S.; Farmer, H.; Krusin, L.; Cronin, K. Status of Animal Welfare Research in Zoos and Aquariums: Where Are We, Where to Next? *J. Zoo Aquar. Res.* **2020**, *8*, 166–174. [CrossRef]
57. Harrison, M.A.; Hall, A.E. Anthropomorphism, Empathy, and Perceived Communicative Ability Vary with Phylogenetic Relatedness to Humans. *J. Soc. Evol. Cult. Psychol.* **2010**, *4*, 34–48. [CrossRef]
58. Young, R.J. *Environmental Enrichment for Captive Animals*; Blackwell Scientific Publications: Oxford, UK, 2003.

59. Quadros, S.; Goulart, V.D.L.; Passos, L.; Vecci, M.A.M.; Young, R.J. Zoo Visitor Effect on Mammal Behaviour: Does Noise Matter? *Appl. Anim. Behav. Sci.* **2014**, *156*, 78–84. [CrossRef]
60. Rabat, A. Extra-Auditory Effects of Noise in Laboratory Animals: The Relationship between Noise and Sleep. *J. Am. Assoc. Lab. Anim. Sci.* **2007**, *46*, 35–41. [PubMed]
61. Rabat, A.; Bouyer, J.J.; Aran, J.M.; Courtiere, A.; Mayo, W.; Le Moal, M. Deleterious Effects of an Environmental Noise on Sleep and Contribution of Its Physical Components in a Rat Model. *Brain Res.* **2004**, *1009*, 88–97. [CrossRef] [PubMed]
62. Learmonth, M.J. Dilemmas for Natural Living Concepts of Zoo Animal Welfare. *Animals* **2019**, *9*, 318. [CrossRef] [PubMed]
63. Pelletier, C.; Weladji, R.B.; Lazure, L.; Paré, P. Zoo Soundscape: Daily Variation of Low-to-high-frequency Sounds. *Zoo Biol.* **2020**, *39*, 374–381. [CrossRef] [PubMed]
64. Mheidly, N.; Fares, M.Y.; Zalzale, H.; Fares, J. Effect of Face Masks on Interpersonal Communication During the COVID-19 Pandemic. *Front. Public Health* **2020**, *8*, 582191. [CrossRef] [PubMed]
65. Kim, G.; Seong, S.H.; Hong, S.-S.; Choi, E. Impact of Face Masks and Sunglasses on Emotion Recognition in South Koreans. *PLoS ONE* **2022**, *17*, e0263466. [CrossRef] [PubMed]
66. Clark, F.E.; Fitzpatrick, M.; Hartley, A.; King, A.J.; Lee, T.; Routh, A.; Walker, S.L.; George, K. Relationship between Behavior, Adrenal Activity, and Environment in Zoo-housed Western Lowland Gorillas (*Gorilla gorilla gorilla*). *Zoo Biol.* **2012**, *31*, 306–321. [CrossRef] [PubMed]
67. Sherwen, S.; Harvey, T.; Magrath, M.; Butler, K.L.; Fanson, K.; Hemsworth, P.H. Effects of Visual Contact with Zoo Visitors on Black-Capped Capuchin Welfare. *Appl. Anim. Behav. Sci.* **2015**, *167*, 65–73. [CrossRef]
68. Parr, L.A.; Waller, B.M. Understanding Chimpanzee Facial Expression: Insights into the Evolution of Communication. *Soc. Cogn. Affect. Neurosci.* **2006**, *1*, 221–228. [CrossRef]
69. Rose, P.E.; Brereton, J.E.; Rowden, L.J.; de Figueiredo, R.L.; Riley, L.M. What's New from the Zoo? An Analysis of Ten Years of Zoo-Themed Research Output. *Palgrave Commun* **2019**, *5*, 128. [CrossRef]
70. Moss, A.; Esson, M. Visitor Interest in Zoo Animals and the Implications for Collection Planning and Zoo Education Programmes. *Zoo Biol.* **2010**, *29*, 715–731. [CrossRef] [PubMed]
71. Wilson, J.K.; Nageotte, N.L.; Pletcher, N. Evoking Empathy—An Overlooked Role of Animal Statues in Zoos. *Zoo Biol.* **2022**, *2022*, 21691. [CrossRef] [PubMed]
72. Miralles, A.; Raymond, M.; Lecointre, G. Empathy and Compassion toward Other Species Decrease with Evolutionary Divergence Time. *Sci. Rep.* **2019**, *9*, 19555. [CrossRef] [PubMed]
73. Yue, D.; Tong, Z.; Tian, J.; Li, Y.; Zhang, L.; Sun, Y. Anthropomorphic Strategies Promote Wildlife Conservation through Empathy: The Moderation Role of the Public Epidemic Situation. *Int. J. Environ. Res. Public Health* **2021**, *18*, 3565. [CrossRef]
74. McCurry, J. Japanese Aquarium Urges Public to Video-Chat Eels Who Are Forgetting Humans Exist. Available online: https://www.theguardian.com/world/2020/may/01/japanese-aquarium-urges-public-to-video-chat-eels-who-are-forgetting-humans-exist (accessed on 11 April 2022).
75. Roach, A. London Zoo Keepers Reveal How They Are Caring for the Animals during the Coronavirus Lockdown. Available online: https://www.google.com/url?q=https://www.standard.co.uk/news/uk/london-zoo-coronavirus-lockdown-a4405861.html&sa=D&source=docs&ust=1649323231971624&usg=AOvVaw01IWWQTJeQ5JvQFWm66gTj (accessed on 3 April 2022).
76. MIND. How Has the Coronavirus Pandemic Impacted Our Mental Health? Available online: https://www.mind.org.uk/media-a/5929/the-mental-health-Emergency_a4_final.pdf (accessed on 4 April 2022).
77. Appel, G.; Grewal, L.; Hadi, R.; Stephen, A.T. The Future of Social Media in Marketing. *J. Acad. Mark. Sci.* **2020**, *48*, 79–95. [CrossRef] [PubMed]
78. Gusenbauer, M.; Haddaway, N.R. Which Academic Search Systems Are Suitable for Systematic Reviews or Meta-analyses? Evaluating Retrieval Qualities of Google Scholar, PubMed, and 26 Other Resources. *Res. Syn. Meth.* **2020**, *11*, 181–217. [CrossRef]
79. Haddaway, N.R.; Collins, A.M.; Coughlin, D.; Kirk, S. The Role of Google Scholar in Evidence Reviews and Its Applicability to Grey Literature Searching. *PLoS ONE* **2015**, *10*, e0138237. [CrossRef]
80. The National Academies of Science, Engineering & Medicine Building the Knowledge Base for Effective Science Communication. *Communicating Science Effectively: A Research Agenda*; National Academies Press: Washington, DC, USA, 2017; pp. 81–100.