



Shows, positive for all?

The effect of birds' engagement in shows on their welfare in zoological settings

Saskia Verbruggen

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Swedish University of Agricultural Sciences, SLU

Department of Applied Animal Science and Welfare

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Saskia Verbruggen

Supervisor: Jenny Loberg, Sweden's agricultural university,
Department of Applied Animal Science and Welfare

Examiner: Maria Andersson, Sweden's agricultural university,
Department of Applied Animal Science and Welfare

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Swedish University of Agricultural Sciences

Faculty of Animal Biosciences

Department of Applied Animal Science and Welfare

Abstract

Zoological institutions often use shows or educational presentations as a form of visitor education on species and nature conservation. Nevertheless only 2% of current animal welfare literature is dedicated to the impact of shows on animal welfare, even though shows can influence welfare through multiple factors. Visitor numbers during show, training methods used for participation in a show, zookeeper interactions during shows, housing of show animals or whether shows are enriching can all influence welfare. Bird shows are among the most advertised presentations on zoological institutions' websites, yet empirical data on the effect of birds' engagement in a show on their welfare is lacking. This study investigated behavioural data of nine birds of five different species in two different zoological settings to see whether behaviour changed on days birds participated in a show and days they did not participate. To further investigate the effect of show, behaviour was compared between before and after show. Behavioural changes are used as an indicator for animal welfare. Birds showed an increase in active and natural behaviours on show days, compared to no-show days, indicating enhanced welfare. Abnormal behaviours increased on show days, however comparisons between before and after show, suggests that these behaviours were mainly anticipatory, since they decreased after show. For one individual anticipatory behaviour seemed to escalate into frustration, indicating that results differed between different species and individuals. Overall, this study suggests that bird shows can have a neutral to positive effect on bird welfare, depending on bird species and individual. To further enhance the welfare of ambassador birds, future research should specifically focus on what it is that motivates different bird species and individuals to participate in a show.

Keywords: Animal welfare, birds, shows, educational presentation, anticipatory behaviour, natural behaviour, zoos

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Abbreviations

Abbreviation	Description
AVI	Animal Visitor Interaction
AW	Animal Welfare
EAZA	European Association of Zoos and Aquariums
EP	Emerald Park
IAATE	The International Association of Avian Trainers and Educators
KD	Kolmårdens Djurpark
NSD	No-show Day
PRT	Positive Reinforcement Training
SD	Show Day
SGHB	Southern Ground hornbill
WAZA	World Organization of Zoos and Aquariums

1. Introduction

Modern zoos have five main goals; conservation, research, education, entertainment and wellbeing, both for humans and animals (Fernandez et al. 2009; Rose & Riley 2022). These goals are also reflected in EU legislation concerning zoological institutions. Guidelines for member states on zoo legislation are set in The EU Zoo Directive (Council of the European Union 1999). Article 1 of the directive (1999/22/EC) states that zoos should play a role in the conservation of biodiversity, while article 3 (1999/22/EC) states that zoos must participate in research, promote public education on biodiversity and conservation and that zoos must provide care to ensure biological and behavioural needs of animals are met (Council of the European Union 1999). Thus, stating all the goals except entertainment.

Worldwide, zoos attract over 700 million visitors per year (Gusset & Dick 2011). For most visitors the main reasons to visit zoos are recreation and education (Villarroya et al. 2024). 72% of these visitors visit zoos with a learning objective in mind (Roe & McConney 2015). This creates a large potential to educate public on nature conservation. Next to that, zoos depend on the attraction of visitors for their income. This generated income can then be used for conservation efforts, animal welfare (AW) and research (Fernandez et al. 2009). Therefore, entertainment is an important goal for modern zoos.

Animal – visitor interactions (AVI's) combine recreational and educational goals. In AVI's visitors can enjoy being close to exotic animals, and AVI's present opportunities to educate visitors on animal species and conservation efforts. D'Cruze et al. (2019) showed that a majority (75%) of zoos associated with the World Organization of Zoos and Aquariums (WAZA) offered some form of AVI on their website. AVI's range from close-up encounters with animals for a small number of visitors, to walk-through enclosures or shows and educational presentations, where animals are shown in front of a large group of visitors (D'Cruze et al. 2019).

There are many organizations that have concerns about animal welfare in zoos, especially when these animals are used in AVI's and shows (e.g. Born free 2021; PETA 2021; World Animal Protection 2023). Shows or educational presentations with marine mammals are particularly under scrutinization by animal welfare activists (World Animal Protection 2023; Rose et al. 2023). Marine mammal parks are closing (Sandeman 2025) or stop with their marine mammal shows (BBC 2017) and governments are banning use of marine mammals in entertainment (World Animal Protection 2025). But not only marine mammals attract attention of animal activists. Shows with birds are also questioned for their educational value and their effect on AW (PETA n.d.). To address these concerns zoos and specifically AVI's must facilitate visitor education while maintaining

good welfare for animals. If zoos want to continue with this form of education, scientific knowledge is needed to establish whether shows decrease, increase or have no effect on AW.

Studies on AW in AVI's show contradictory results, where sometimes AVI's have a positive effect on AW (Fernandez et al. 2021), sometimes a negative effect (Freeland et al. 2020) and sometimes no effect (Lin et al. 2025). The impact of AVI's on AW depends on species (Fernandez et al. 2009), personality of animals (Watters & Powell 2012), training and raising methods of animals (Martin et al. 2024) and way of implementation of AVI's (D'Cruze et al. 2019), which makes it a complicated subject. There particularly seems to be a lack of research on impact of show or educational presentation on AW, only 2% of zoo welfare related literature addresses shows (Binding et al. 2020; Woods et al. 2022). A review by Cooper-Rogers et al. (2026b) showed that the impact of shows or educational presentations on animal welfare are mostly neutral, sometimes positive and sometimes negative, and generally outcomes were mixed. For example, one of such studies showed that participating in an interactive presentation where large numbers of visitors watched a regular training session with servals did not affect the welfare of these animals (Acaralp-Rehnberg et al. 2020).

1.1 Shows or educational presentations

D'Cruze et al. (2019) describes shows as:

“Interactions with trained staff and or visitors where a captive wild animal, provides a demonstration of either natural or non-natural behaviour for visitors, with or without a physical barrier between them, under official staff supervision. Visitors are likely to have a relatively low expectation of direct contact.” (D'Cruze et al. 2019)

Shows are the third most popular animal-visitor interaction in WAZA zoos, approximately 30% of WAZA zoos offer some form of display or show (D'Cruze et al. 2019). Often these shows involve music, amplified speaking and sometimes also light effects. Large numbers of visitors are engaged with shows and in some shows one or two visitors can be selected to have a more close-up meeting with an animal (Whitehouse-Tedd et al. 2020). When shows are mainly focused on educational aspects and only natural behaviours are demonstrated they are called educational presentations, whereas when shows are more directed at entertainment and also unnatural behaviours or natural behaviours in unnatural context are performed they are called performances (Whitehouse-Tedd et al. 2020). These unnatural behaviours or natural behaviours in unnatural context (e.g. natural hunting behaviours with props or solving puzzles) can be used as 'educational hooks', where the behaviour is performed to attract visitor attention and explain animal's capabilities in nature (Whitehouse-Tedd et al. 2020). In this

report the word show will be used for both educational presentations and performances.

Bird shows are often more educational presentations, where a person talks about characteristics of bird species flown and their conservation problems, while the same or different persons are showing/flying these birds (from personal observations). Different kinds of bird species are used for shows, for example parrots, birds of prey, owls or vultures or any combination thereof, and they occur on all inhabited continents (Whitehouse-Tedd et al. 2020). Humour and educational hooks are sometimes used in bird shows (personal observations). Shows often feature birds separately or in groups of the same or of different species (Whitehouse-Tedd et al. 2020; Massen et al. 2022). Show birds can either be bred in captivity or have come from rehabilitation programs (Martin et al. 2024). Different species, different individuals and different background of birds all influence their adaptability to perform in shows (Watters & Powell 2012; Martin et al. 2024).

Involvement of visitors in AVI's and shows has been shown to enhance conservation efforts and knowledge in these visitors, by enhancing the time spent with an exhibit and by creating emotional connections (Povey & Rios 2002; Visscher et al. 2009; Godinez & Fernandez 2019; Spooner et al. 2021; Lyon et al. 2024). Using interpretative presentations, where a zoo employee tells about animals and/or conservation, showed more potential in producing knowledge then stating only facts or traditional exhibits (Povey & Rios 2002; Visscher et al. 2009). Visitors that attended a show showed significantly more animal knowledge, but just a weak positive change in conservations awareness after the show (Spooner et al. 2021).

1.2 Legal and professional guidelines for shows

EU legislation specifically directed at zoo animal welfare is set up through the Zoo directive (Council Directive 1999/22/EC, 1999). The Zoo Directive has no specific article on shows and AVI's. National laws in The Netherlands, through the 'Besluit houders van Dieren, 2014' (Decree on the Keepers of Animals) and in Sweden, through the Animal Welfare Act, 2018 also have no specific legislation on AVI's (Government of the Netherlands 2014; SFS 1988:534). Both countries follow the EU Zoo directive and state that licensed zoos must support education, conservation and research and that animal welfare must be ensured (Government of the Netherlands 2014; SFS 1988:534).

Any guidelines on AVI's come from organizations like WAZA and European Association of Zoos and Aquariums (EAZA). Chapter 10 of WAZA's 'Advancing Animal Welfare, The World Zoo and Aquarium Animal Welfare Strategy' (2025) and chapter 4.5 of EAZA's 'Standards for Welfare, Accommodation and Management for Animals in Zoos and Aquariums' (2024) cover AVI's (Powell

2025; European Association of Zoos and Aquariums (EAZA) 2024). These guidelines must be followed by EAZA or WAZA members, but not by nonmembers. Both WAZA and EAZA support AVI's only when they are implemented to raise conservation awareness, when animal welfare is not compromised and when animals perform only natural behaviours (Powell 2025; European Association of Zoos and Aquariums (EAZA) 2024).

1.3 Potential impact of shows on animal welfare

Even though birds are the most common taxa used in demonstrations (D'Cruze et al. 2019), only 10% of zoo welfare literature is directed at birds (Binding et al. 2020; Woods et al. 2022), resulting in a large underrepresentation of studies directed at bird welfare especially of birds participating in shows.

Notwithstanding, shows potentially have an influence on AW. Next to the individual and species characteristics of birds (Watters & Powell 2012; Martin et al. 2024), there are external factors that could contribute to this influence on AW during a show. Influences could come from visitor presence, artificial sounds and lights, training methods used to train behaviours and more frequent and closer contact with zookeepers (Ward & Melfi 2015; Martin et al. 2024). Shows also provide a potential form of enrichment, which can be beneficial for AW (Swaigood & Shepherdson 2005). And lastly, birds participating in shows are sometimes housed differently than birds not participating in shows (Whitehouse-Tedd et al. 2020), which might influence AW. According to Whitehouse-Tedd et al. (2020) faecal cortisol levels in birds suggest that birds performing in shows are less stressed than birds on display in aviaries, which could potentially be because of positive reinforcements and less boredom.

1.3.1 Visitors

Visitors can have a positive, negative or neutral influence on animals in zoos, by the visual and auditorial stimuli they produce (Fernandez et al. 2009). A negative influence is seen when animals avoid visitors, show more stereotypic behaviour and are more vigilant, while a positive effect is seen when animals try to interact with visitors or approach visitors (Williams et al. 2023). If there is a neutral visitor effect, animal behaviour does not change (Williams et al. 2023).

Visitor – animal interactions are complex, and are not only influenced by the sheer presence of visitors, but also by the number, proximity and behaviour of visitors as well as by environmental variables (Boyle et al. 2020; Rose et al. 2020). In a walk-through mixed-species aviary in Zoo Tampa, Lowry Park, Florida, USA visitors seemed to have a neutral effect on bird welfare, since with increasing visitor numbers, birds moved to different areas in their enclosure but did not alter their behaviour pattern (Blanchett et al. 2020).

Next to that, different species and different individuals within species react differently towards visitors (Boyle et al. 2020; Williams et al. 2023). Literature review shows that most bird species react neutrally towards visitors, while species from the order *Psittaciformes* (parrots) had more often than expected a positive response towards visitors (Williams et al. 2023). A study in Memphis Zoo, Memphis, Tennessee, USA on 16 different species, showed that individuals within species varied in their behavioural responses towards visitors (Boyle et al. 2020).

1.3.2 Sounds and lights

Shows in zoos are directed at large groups of visitors with the intention of getting information across, this often requires using amplified speaking. Next to that, to make shows more entertaining music and sometimes light effects are supplemented to shows (personal observations). These artificial sounds and lights might have an impact on AW.

Birds and especially birds of prey have a highly developed visual system, which they use for navigation, foraging, and social behaviours (Fox 1995; Martin 2022). Birds have a broader colour spectrum, including UV-lights, than humans, they have two focal spots, they process images faster and they see objects more detailed at a far greater distance than humans can (Fox 1995). Birds of prey can also hear a wider range of frequencies than humans and they discriminate between frequencies better than humans, and this is even more pronounced for forest and nocturnal birds of prey (Fox 1995). This means that birds live in a completely different light and sound world than humans. Adding artificial sounds and lights, which are unfamiliar and non-biologically relevant (Lara & Vasconcelos 2019) to the environment can thus be a welfare concern for birds, even if we as humans do not perceive these lights or sounds as disturbing.

Some studies have tried to investigate the effect sounds have on behaviour and welfare of animals, but no studies have been found that investigate the effects of these artificial sounds during show performances. A study on sound environment and its effect on bird behaviour in zoos showed that this relation was complex and relied on individuals, species and enclosures (Rose et al. 2022). In a study on two species of cockatoos (*Cacatua sulphurea citrinocristata* and *Cacatua moluccensis*) a difference was shown in the response of each species to the presence of children playing in the nearby playground or standing in front of the enclosure, which resulted in different sound environments, where one species retreated from visitors while the other became more social (Collins & Marples 2015). A study on five different hornbill species showed that an increase in noise resulted in an increase in activity and a decrease in resting, which would be a reason to monitor welfare closely (Tay et al. 2025). Lastly a study on the effect a concert in the zoo had on behaviour of 22 species showed that bird species were

mainly affected in their sleeping period due to higher noise levels (Harley et al. 2022). The above studies show that sound can have a large influence on bird behaviour, suggesting that amplified sounds in shows might affect welfare of birds flying in shows.

Lights in shows and their effect on bird welfare is also not studied, as far as could be found. But there are studies to indicate that lights do affect behaviour of birds. Adding UV-light to bird enclosures resulted in an increase in staying in this light (Ross et al. 2013; Bryant et al. 2022), and in a change in social behaviour (Ross et al. 2013). An event that occurs often in zoos is ZooLights, a commonly used term for holiday lighting festivals held in zoos during winter months, where artificial lighted fixtures are displayed after normal opening hours, potentially influencing animals. A study by Readyhough et al. (2022) investigated the effect of ZooLights on a pair of hornbills' (*Buceros bicornis*) behaviour. The results suggested that these birds were not affected in their behaviour due to extra lights or a higher number of visitors, any changes in behaviour were mainly due to the breeding season (Readyhough et al. 2022). This last study suggests that extra lights in a show might not be of importance for AW. Most bird shows are held outside in natural surroundings during daylight, suggesting there might be no influence of artificial lighting at all.

1.3.3 Training

Birds performing in shows are trained to fly from one point to another or to perform behaviours on cue, which can be natural, sometimes involving non-natural attributes, or non-natural (Whitehouse-Tedd et al. 2020; Cooper-Rogers et al. 2026a). How birds are trained has an influence on AW (Martin et al. 2024). To ensure optimal welfare for animals, every trainer should pursue a training method that is the most positive and least intrusive option available (Friedman 2009; Martin et al. 2024).

Some bird shows still utilize some form of restraint (personal observation). Birds are tethered to the glove during shows or to perches between shows to keep them from flying away. EAZA guidelines state that tethering is acceptable but not for all bird species, for instance caracara's (*Falconidae* family / *Polyborinae* subfamily), new world vultures (*Cathartidae* family) and secretary birds (*Sagittarius serpentarius*) should not be tethered (Habben & Mbe n.d.). It seems though that there is an increase in zoological institutions that keep their demonstration birds in aviaries and fly these birds directly from their aviaries, without any physical restraints (personal observations).

Having choice in one's life and control over one's environment is reinforcing for many species (Ackerlund Brandt et al. 2015; Decker et al. 2023). Keeping birds restraint takes away choice and creates potential for injury (Martin et al. 2024). While flying birds from their aviaries gives birds an option to choose if

they want to participate in a show. Nonetheless, it is not just important to give animals a choice but one should provide animals with genuine choice, which means giving more than one option to choose from (Martin et al. 2024). For example, doing either behaviour A, fly in the show, or behaviour B, stay in your aviary, will be rewarded equally. Thus, by creating genuine choice in animal training AW can be improved.

Training using positive reinforcement (PRT) is enriching for animals, thus enhancing AW (Fernandez 2022). PRT is a method that can be used for birds. PRT often uses food as a primary reinforcer, which indicates some form of weight or food management might be needed, since there must be motivation for these reinforcers. There are many dangers, especially in zoological settings, that birds can encounter when free flying. Other zoo animal exhibits, like a big carnivore's exhibit, where a bird could accidentally land, wild bird species that might chase or hunt birds or man-made structures like rollercoasters can all pose threats to birds. Therefore motivation to come back to the trainer or the aviary is crucial in free flying birds, thus making weight and food management a regularly used tool in bird training (Hellmuth 2020). The International Association of Avian Trainers and Educators (IAATE) (2019) defines food management as:

“a way of managing when and how food is delivered, what food items are offered, and the ratio of food items offered can create desire to present behaviours for food reinforcers.” (IAATE 2019)

Weight management is defined by IAATE as maintaining a weight range where birds show acceptable behavioural responses and are still healthy (IAATE 2019). EAZA guidelines state that weight management is an acceptable way of training birds, if done by experienced trainers and always with AW in mind (Habben & Mbe n.d.). According to IAATE's position statement on weight management (2019) the goal of weight management is to fly birds at the highest healthy weight possible. Behavioural responses in combination with health should be used as a tool to assess the appropriate weight range for a bird, but other factors such as weather, age, species and individual can influence behaviour as well (IAATE 2019). Birds who do not cooperate in training, are not always satiated, there might be other motivations, such as relationship with the trainer, physical ability to perform the behavior, and past experiences with the behavior that have an influence on a bird's decisions to fly (Martin 2020). Therefore, training free-flighted birds without using restraints and without relying too much on weight management requires exceptional knowledge and skill from animal trainers (Martin et al. 2024).

When conducted properly, PRT can be used to train animals to get accustomed to visitors, new environments and music and lights. Thus, training birds to perform in shows if done by PRT can enhance bird welfare (Martin et al. 2024).

On the other hand, when training is done using force or restraints or too much reliance on weight management, welfare can be decreased.

1.3.4 Zookeeper interactions

Animals come across zookeepers many times during a day in many different situations. Both potentially positive, delivering food or enrichment, or potentially negative, handling for medical purposes or cleaning. Human-animal relations can be enriching to animals kept in a zoo environment (Claxton 2011). Especially bonds between zookeepers and animals have an influence on AW (Ward & Melfi 2015; Brando et al. 2023).

This zookeeper-animal bond depends on zookeepers' attitude and knowledge of animals and on a person's skill to read animals' subtle body language (Hellmuth 2020; Brando et al. 2023). Positive bonds can be formed through positive interactions with the animals by providing enrichment or by training with PRT (Brando et al. 2023). Positive bonds will result in improved AW (Ward & Melfi 2015). Especially solitary housed animals are more likely to form relationships with their keepers, because they are more influenced by these interactions (Ward & Melfi 2015).

Birds used in shows can benefit from creating better keeper-animal bonds through PRT, and since they are quite often housed alone this has the potential to be even more beneficial (Ward & Melfi 2015). Therefore, zookeeper interactions potentially lead to improved welfare for birds in shows compared to birds not in shows, which are often not or hardly trained (Hellmuth 2020).

1.3.5 Enrichment

Shows can provide environmental, mental, physical and social enrichment. And since enrichment can enhance welfare of animals kept in zoos and aquariums (Swaigood & Shepherdson 2005; Decker et al. 2023), shows have a potential to be beneficial for AW.

By taking the animals from one environment, their enclosure, to a new environment, the show area, birds will experience new stimuli potentially being enriching, thus providing environmental enrichment. Mental stimulation can come from PRT (Fernandez 2022), from challenging birds to respond to cues and from showing natural behaviours, that birds otherwise might not be able to perform. An example would be a seriema (*Cariacidae* family) hitting a plastic lizard against a rock, to show hunting behaviours in a demonstration (Whitehouse-Tedd et al. 2020). Flying in a show will provide physical stimulation, more than most aviary housed birds get. Next to that, shows can increase number of social interactions between birds, zookeepers and visitors, which could be enriching depending on species and individual (Claxton 2011; Collins & Marples 2015; Truax & Vonk 2024).

1.3.6 Housing

Enclosure design is an important part of AW (Rose & Hickey 2025). And although EAZA guidelines for demonstration animals state that these animals should be kept according to the same standards as exhibit animals, sometimes housing conditions for show animals may not be as optimal as for exhibit animals (Whitehouse-Tedd et al. 2020; European Association of Zoos and Aquaria (EAZA) 2024).

Some zoos may have their birds perched on blocks between shows during the day or even during a whole show season, limiting their mobility, to make it easier to retrieve them before the show (personal observations). Sometimes birds are even wing-clipped to restrict them from flying away (Martin et al. 2024). It is becoming more common to see free flying birds in demonstrations and birds housed in aviaries all year round (Martin et al. 2024). Some zoos have smaller aviaries for demonstration birds, than they have for exhibit birds and in some zoos demonstration birds that are naturally social are housed alone to make it easier for use in shows (personal observations). Zookeepers might sometimes perceive shows as enriching for animals, which could lead to more barren enclosures and less other enrichment given (personal experience).

When demonstration area and aviaries are not situated in proximity, birds might have to be transported between these areas or stay in holding boxes during show time. Studies show that keeping animals for longer periods in pre-transport holding places and even short time transport will induce stress in animals (Della Costa et al. 2013; Bejaei & Cheng 2014). Not being trained properly for transport or being restraint in a holding or transport box for extended times, might impact AW negatively (Pratsch et al. 2018).

1.4 Aim of study

Since there are multiple factors potentially influencing AW during shows and a lack of research on bird welfare, the aim of this study was to investigate if birds' engagement in a show had an influence on their welfare in zoological settings. Changes in bird behaviour were used as an indicator for AW. Answers were sought to the following questions:

- Is bird behaviour changing on days when birds participate in a show compared to days not participating in a show? If yes, which behaviours are changing?
- Are there changes in bird behaviour before and after participating in a show?
- Do these changes tell us something about bird welfare?

The hypotheses were that participation in a show will affect bird behaviour and that participation in a show will increase welfare of birds.

2. Materials and methods

2.1 Materials

This study was conducted in two EAZA accredited zoos, Kolmårdens Djurpark (KD), Kolmården, Sweden and Emerald Park (EP), Ashbourne, Ireland. Both zoos have a free flying bird show on scheduled times, where birds fly and show natural behaviours for a group of visitors, while a presenter talks about bird specifics and conservation efforts for these species. Both zoos are a combination of zoo and theme park.

Ethical approval was granted by the research committees from both zoos. No other ethical approval was needed, since no alterations were made to normal husbandry practises.

2.1.1 Study subjects

A total of nine individuals from five different bird species were observed during this study. **Table 1** lists names, species, zoo and sex of all birds included in the analyses. Bird ages ranged from six years to at least 24 years in KD, where not all ages could be determined, and between five and six years in EP. **Table 2** lists average weights of these birds during different observation periods.

Short species description

These different bird species differ in their natural environment, their diet, their hunting behaviour and their social behaviour.

Harris's hawks (*Parabuteo unicinctus*) are birds of prey that live in social groups in Southern America in semi-open desert lowlands (Dwyer & Bednarz 2020). They feed mostly on medium-sized mammals but also take quail, medium-sized birds, and reptiles (Dwyer & Bednarz 2020). Harris hawks have complex social hierarchies and hunt and breed in a cooperative way (Dwyer & Bednarz 2020). Their IUCN status is least concern (<https://www.iucnredlist.org/>).

Lanner falcons (*Falco biarmicus*) can be found in a wide range of habitats in southern Europe and Africa (Kemp & Marks 2020). They hunt mainly birds but also small mammals, bats and reptiles and live alone or in pairs (Kemp & Marks 2020). Their IUCN status is least concern (<https://www.iucnredlist.org/>).

Laggar falcons (*Falco juggar*) live on the Indian subcontinent in open arid country (Clark et al. 2020). Their main prey are birds, but they also hunt small mammals and insects (Clark et al. 2020). They are solitary birds except during the mating season (Clark et al. 2020). Their IUCN status is near threatened (<https://www.iucnredlist.org/>).

Table 1. Information about the study subjects. Name, species, which zoo they live (KD is Kolmårdens Djurpark, EP is Emerald Park) and sex.

Name	Species	Zoo	Sex
Hans	Military macaw (<i>Ara militaris</i>)	KD	M
Kicki	Laggar falcon (<i>Falco jugger</i>)	KD	F
Batulli	Southern ground hornbill (<i>Bucorvus leadbeateri</i>)	KD	F
Teku	Southern ground hornbill (<i>Bucorvus leadbeateri</i>)	KD	M
Wayne	Harris's hawk (<i>Parabuteo unicinctus</i>)	KD	M
Victory	Harris's hawk (<i>Parabuteo unicinctus</i>)	KD	F
Tony	Harris's hawk (<i>Parabuteo unicinctus</i>)	EP	M
Allen	Harris's hawk (<i>Parabuteo unicinctus</i>)	EP	M
Cleo	Lanner falcon (<i>Falco biarmicus</i>)	EP	F

Table 2: Weights of birds in the different periods (grams) and the difference between P1 and the average of P2 and P3 (%).

	Weight P1 (gram)	Weight P2 (gram)	Weight P3 (gram)	Difference p2/p3 and p1 (%)
Hans	915	918	906	0.33
Kicki	609	568	570	6.57
Batulli	3795	3330	3352	11.96
Teku	3671	3378	3379	7.97
Wayne	704	675	654	5.61
Victory	1055	942	936	11.00
Tony	800*	618	631	21.94
Allen	875*	692	699	20.51
Cleo	710*	641	613	11.69

* These weights are estimates, since the birds in Emerald Park are not weighed during winter.

Military macaws (*Ara militaris*) are parrots from South America who live high up in the canopy of trees on forested foothills and canyons and they live in pairs and loose groups made up of pairs (Collar et al. 2020). They feed on seeds, leaves and fruits, but they have a narrow diet, because they choose just a small percentage of plant species available to them (Collar et al. 2020). Their IUCN status is vulnerable (<https://www.iucnredlist.org/>).

Southern ground hornbills (SGHB) (*Bucorvus leadbeateri*) live in eastern Africa and can be found mainly in woodlands, savanna areas and grasslands (Kemp & Boesman 2020). They live in groups of two to nine individuals, and they have a cooperative breeding system (Kemp & Boesman 2020). Their diet consists mainly of arthropods, but also snails, frogs and toads, and they sometimes

take larger prey such as snakes, lizards, rats, hares, squirrels or tortoises (Kemp & Boesman 2020). Fruits and seeds are also recorded in their diet, although infrequently (Kemp & Boesman 2020). The IUCN status of the SGHB is vulnerable (<https://www.iucnredlist.org/>).

2.1.2 Husbandry and housing

Kolmårdens Djurpark

In KD there was a difference between winter housing and summer housing due to weather conditions in winter. Winter aviaries for Harris's Hawks, falcon and SGHB were indoors and in another part of the zoo compared to summer aviaries. Winter aviary sizes ranged from approximately 20m x 9m x 5m (L x W x H; length x width x height) for the SGHBs, 8,8m x 8,3m x 3m (L x W x H) for the falcon, 15m x 4,3m x 5,1m (L x W x H) for the Harris's hawks and 9m x 4,8m x 2,6m (L x W x H) for the macaws. Winter aviaries were heated up to approximately 15-20°C. The artificial lighting in these aviaries was set on a timer resulting in day times from approximately 08:00h to 20:00h, which is longer than natural day light in winter in Sweden.

Summer aviaries were with mesh on top, but all contained shelters for birds to hide from weather conditions. For the military macaws their summer aviary was their winter aviary with access to an additional outside aviary. Summer aviaries ranged from approximately 26m x 13,5m x 5-6,8m (L x W x H) for the SGHBs, 10,6m x 10,3m x 6,3m (L x W x H) for the falcon and 18,7m x 8,2m x 4,8m (L x W x H) for the Harris's hawks. The additional outside aviary for the macaws was 9m x 2,3m x 3,8m (L x W x H). All aviaries were decorated with natural perches and perches with astroturf. A radio was played in the proximity of the summer and winter enclosures as a form of auditory enrichment for both birds and staff.

Individuals of the same species were housed together. The military macaw was also housed with a conspecific, but since this bird was not flying in shows yet, he was not used for this study. All birds were housed out of sight from visitors and were only seen by visitors during show. Birds could not see but could hear other bird species. They could also see and hear wild bird species and other zoo animals in their summer aviaries. In summer behind-the-scenes tours were given to small groups of visitors who paid an extra fee for this.

In winter birds were weighed and trained in their aviary and fed before approximately 10:00h. In summer birds were weighed in the morning, but training, flying and feeding occurred during and after training or show. Training was based on positive reinforcement training with food as a reinforcer. No restraints were used, but weight management was used to provide the appropriate motivation for flying. All cleaning occurred before 10:00h. Enrichment was given on a regular basis, according to a pre-set plan on when enrichment should be

given. What kind of enrichment was given, was decided daily. Enrichment could be environmental enrichment, like branches or new perches, or food enrichment, where food was hidden in paper bags, carton boxes or in bowls with leaves and twigs.

Parrots received a diet of Harrison's Adult Lifetime Coarse pellets (Harrison's Bird Foods, Brentwood, TN), fruit, vegetables and nuts. Falcon and hawks received a diet of mice, rats, one-day-old chicken, quail, mealworms and crickets. SGHBs had additional pinkies and vegetables in their diet compared to falcon and hawks, and they received ad libitum food in winter, to stimulate reproduction. Bird of prey food was supplemented with additives made in-house for predatory mammals and mainly consisting of calcium.

The zookeepers that were responsible for taking care of the show birds were also responsible for other zoo animals and visitor encounters.

Emerald Park

In EP birds were housed in the same aviary all year round. Harris's hawks moved to a new aviary prior to the first observations round and the falcon moved to a new aviary after the first observation round, both due to management practices. Aviary size for Harris's hawk was 4,5m x 8,5m x 3,5m (L x W x H). The falcon had an old aviary size of 5,5m x 4,5m x 3,5m (L x W x H) and a new aviary size of 5,83 x 3,23m x 2,85m (L x W x H). All aviaries contained shelters or had an inside enclosure attached to their aviary. Harris's hawks were visible to visitors during park opening hours; the falcon was housed out of sight of visitors. All aviaries were decorated with natural perches and perches with astroturf. There were different substrates in different parts of the enclosure of the Harris's Hawks. Harris's hawks were housed next to other species of birds on both sides. These aviaries were separated by mesh walls and birds could see and hear each other. Both the old and new aviary of the falcon had solid wooden walls with a window with bars on one side and were in the same area of the park. The falcon could only see other bird species through this window but could hear other bird species. All aviary's roofs were made of mesh, so birds could see what happened above them.

Enrichment was given daily in accordance with a structured enrichment plan. Environmental enrichment was provided in the form of foreign objects in the enclosures such as balls, pylons or plastic hoses, food enrichment was not given to these birds.

In winter, birds were not weighed or trained, and feeding was done approximately around midday. During this period birds received ad libitum food. Cleaning was done in the morning. In summer, birds were weighed before first show and training, flying and feeding was done during shows or during the day, when not participating in a show. Food reinforcement is used when training birds, mainly in the form of luring (showing food, to lure the bird). Weight management

is an important part of training. Before commencing shows, falcon and Harris's hawks were equipped with anklets and jesses, leather straps around their feet used to hold birds, see **Figure 1**. These were used during transport to restrain birds from flying away, mainly by new staff members.

All birds received a diet of one-day-old chicken, venison, quail, rabbit, Syrian hamsters, rats and mice. DK Zoological Meat Supplement and TRM Biotin were given as vitamin and nutrient supplement three times a week to all birds.

The bird department was responsible for a total of 40 birds, of which 17 were used for display, including the three of this study.



Figure 1: Jesses and anklets fitted on the Harris's Hawks in Emerald Park (photo credit: Emerald Park).

2.1.3 Shows

Kolmårdens Djurpark

Shows in KD happened once or twice a day in spring and summer period. A show featured two to three birds or bird species and lasted approximately 15 minutes. Not all birds were flown in a show every day. Which birds were flown depended on staff available, birds' motivation or weight, training status and weather conditions. This was decided every morning by staff.

Birds were flown directly from their aviaries or carried on hand, while being reinforced for staying, to the demonstration field. All birds, except macaws and SGHBs, received transmitters approximately 15 minutes prior to show time.

One actor and one sound-technician helped with shows. Two to three regular zookeepers and/or seasonal zookeepers flew and cued birds to perform natural behaviours and presented facts about bird species and conservation efforts.

Approximately 500 visitors could be seated, but additional visitors could look from a distance. Show content was highly educational and contained bird specifics and conservation efforts supported by Kolmårdens djurpark, zoos world-wide and Kolmården Foundation.

Emerald Park

Shows in EP occurred one, two or three times a day depending on the time of year and day of the week. A show featured on average three to five birds, or couples of birds and lasted approximately 25 to 30 minutes. A yearly flying plan was made, in which is stated which birds fly in a show during which months, to make sure that all birds fly regularly during the year. This plan was adjusted just before observation period 2, due to changes in staff. Which birds were flown in a show was decided daily by presenters' choice, birds' weight, availability of staff and weather conditions.

Birds were flown from a holding pen just outside their aviary to the demonstration area or were carried, while being restrained, to the demonstration area. Approximately 15 minutes prior to show, birds received a transmitter and the Harris's Hawk that was flying in the show was put in the holding pen. The falcon, depending on the number of staff available was either put on block (see **Figure 2**) after she received the transmitter or carried immediately towards the show.

On average three zookeepers from the bird department were responsible for all aspects of the show, from presenting to flying birds. Approximately 400 – 450 visitors could be seated during show. Show content was highly educational and included species natural behaviour and characteristics as well as different conservation efforts for these bird species.

Since there were some training difficulties, the Harris's hawks could not fly together in a show, and the falcon had issues with coming to the hand to receive a transmitter, birds were not flying as regularly in a show as anticipated. Therefore, for EP a day was also included as a show day if a bird was trained in front of a small audience. In this case a bird was taken out of its aviary to the demonstration field and on the way over there, visitors were asked to come along and watch a training session. Since this involves an audience, although a small number, it can still influence animal welfare.



Figure 2: Falcon tethered to a block. (photo credit: Emerald Park)

2.2 Methods

2.2.1 Data collection

Data on bird behaviour was collected either by live observations, or by observations from camera recordings, when the birds were in their aviaries. In KD some sessions were recorded using GoPro HERO10 Black cameras and then later observed from a computer, while most observations were done live at the zoo. SGHB observations in winter were done using IMOU® cameras directly connected to a monitor just outside their enclosure, since this enclosure was not visible from outside. In EP all aviaries had Reolink® RLC -520A cameras which could be accessed from a home computer using the Reolink application. When in Ireland, some observations were conducted live.

All observations were done in real time using ZooMonitor™ on a Lenovo® TB3-X70F tablet. Both styles of observations, live or from camera, resulted in places where birds could not be seen. In live observations observers' position was adjusted so visibility of animals was as high as possible. For camera observations playback was used to find periods with highest visibility. An example of observer viewpoint, both from camera and live can be seen in **Figure 3**.

An ethogram was created based on published ethograms for these and closely related species (Wickert 2020; Brereton et al. 2021; Jenner & Lewis 2024;

Marcuk et al. 2025), personal communications with experienced zookeepers at both facilities, and preliminary observations (see **Appendix 1**). All behaviours in the ethogram are mutually exclusive, except for some event behaviours, marked in Appendix 1 with an *, which will be counted as occurrence behaviours. Adding an ‘other behaviour’ option, makes the ethogram exhaustive.



Figure 3: An example of observer viewpoint from A) camera or B) live of the Harris's hawk aviary in Emerald Park. The arrows indicate areas where birds will be out of sight from the observer (photo credit: Emerald Park).

Data was collected in 2026 during three different periods. **Table 3** shows observations dates of the different observation periods (P1, P2, and P3) as well as, if zoos are open and how many scheduled shows are given during these observation periods.

- Period 1 (P1) was during winter when there were no shows, and birds were kept on higher weights. In this period training and flying were limited and only in their aviaries.
- Period 2 (P2) was during spring when there were shows but not all days, or birds did not participate every day. In this period birds were weighed and trained daily, and their weight was at such a level that food was a motivator.
- Period 3 (P3) was during summer, when birds participated in shows almost daily.

Table 3. Dates of the observation periods (P1, P2, P3), if the zoo is open to public in that period and number of scheduled shows that will be given per observation period. KD is Kolmårdens Djurpark and EP is Emerald Park.

	Dates	Open to public	Number of shows
P1 KD	9/2 – 26/2	No	0
P1 EP	30/1 – 7/2	No	0
P2 KD	4/5-22/5 and 7/6-25/6	Partly	0 (first part) and 1(second part)
P2 EP	7/6 – 25/6	Yes	1 or 2
P3 KD	29/6 – 13/7	Yes	2
P3 EP	1/7 – 8/7	Yes	3

Per period, birds were observed for 15 minutes continuously, three times a day. An observation round started approximately around 10:00h, 12:30h and 14:00h during P1 and around 11:00h, 13:30h and 15:30h during P2 and P3. Since EP had a third show at 15:30h in P3, the last observation in this period started around 16:00h. Observation of an aviary started at different times on different days, but the order of aviaries was consistent during a day. This to make sure that a single bird was not always observed right after show or cleaning. When using video playback and a bird was not visible on camera, a time was chosen as close as possible to the scheduled observation time, where the bird was visible.

Per bird the aim was to observe 10 SD and 10 NSD. This would have resulted in approximately 450 minutes of observations on show days (SD) and 450 minutes of observations on no-show days (NSD) per bird.

2.2.2 Statistics

Raw data was downloaded from ZooMonitor to organise in Microsoft Excel®. For the statistical analysis program R version 4.5.0 and RStudio® 2026.06.0+242 were used.

Different species used in this study have different behavioural repertoires, and next to that individuals from the same species can behave differently, therefore birds were used as their own control. Since visual observation using histograms,

showed a non-normal distribution of data, differences in occurrence of behaviour were compared between SD and NSD, between before and after show and between summer and winter aviary using a paired Wilcoxon signed-rank test (Fernandez et al. 2025). For the Wilcoxon test the difference in medians for every bird between the two categories are used to calculate ranking.

Visibility during observation sessions varied, therefore duration and frequency of observed behaviour were corrected for the proportion of visible time per observation. Only those behaviours that showed a difference in median or 3rd quantile in explorative statistics using boxplots were tested.

To account for multiple hypothesis testing, p-values were adjusted using the Benjamini–Hochberg procedure, which controls the false discovery rate (Benjamini & Hochberg 1995), instead of the Bonferroni correction, since a Bonferroni correction could lead to an increased risk of Type II errors (Nakagawa 2004).

3. Results

Most birds were observed for 30 sessions on SD and 30 on NSD, except for Kicki (laggar falcon, KD), who was not flown in a show after two show days, resulting in just six observation sessions on SD. This was a decision taken by the trainers, since there were training difficulties with getting her transmitter on. For Tony (Harris's hawk, EP) one session was taken out of the analyses due to being completely out of sight. All birds had 15 sessions on NSD in P1 and P2 and most birds had 15 sessions on SD in P2 and P3. Except for Wayne (Harris's hawk, KD), who had 12 observation sessions on SD in P2 and 18 sessions in P3 and Hans (military macaw, KD), who was not flown in show in P2 but was flown almost every day in P3, resulting in 30 sessions in P3.

Observation time for every session was 15 minutes, but due to the birds being out of sight the average visible time lay between 12 and 15 minutes per session. Before and after show sessions were divided almost equally for most birds. Exceptions are Victory (Harris's hawk, KD), who flew mainly in the first show when there were two shows a day, Hans (military macaw, KD) who flew mainly in the second show when there were two shows a day and Cleo (lanner falcon, EP) who was trained in front of an audience mostly after 15:30. On one show day it was not clear if Allen (Harris's hawk, EP) was flying in the first or the second show, so this observation was taken out of the before and after comparisons. See **Appendix 2** for an overview of the number and division of observations.

3.1 Show day compared to no-show day

After creating boxplots for all behaviours that were seen during the observations, there were three continuous behaviours that showed a numerical difference in median between SD and NSD. These were moving, preening and vigilance with a median of 0.012, 0.016 and 0.834 (proportion per visible time (sec)) for SD and 0.014, 0.010 and 0.746 (proportion per visible time (sec)) for NSD. The behaviours perching and resting both had a median of zero on SD and NSD, but showed a higher 3rd quantile on NSD, respectively 0.0190 and 0.0367 (proportion per visible time(sec)) compared to the 3rd quantile on SD, which were both zero. See **Figure 4** for the boxplots of these continuous behaviours.

For the occurrence behaviours, where the frequency of occurrence is counted per visible second, the behaviours that showed a clear boxplot are casting faeces, scratching and tail shake. Although these behaviours all had a median of 0 (proportion per visible time (freq/sec)) on both SD and NSD, there were numerical differences in the 3rd quantile. For casting faeces these were 0.0011 and 0 (proportion of visible time (freq/sec)) for respectively NSD and SD. For scratching these were 0.0011 and 0.0012 (proportion of visible time (freq/sec)) for

respectively NSD and SD and for tail shake these were 0.0013 and 0.0012 (proportion of visible time (freq/sec)) for respectively NSD and SD. See **Figure 5** for the boxplots of these occurrence behaviours.

Boxplots for tested continuous behaviours

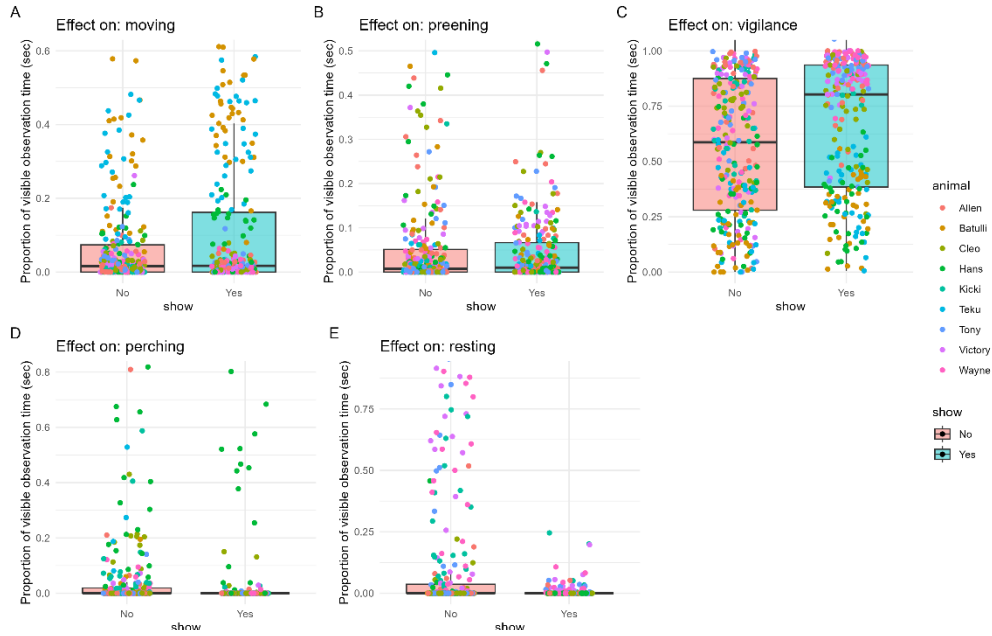


Figure 4: The boxplots for the effect of show on continuous behaviours A) moving, B) preening, C) vigilance, D) perching and E) resting in proportion of visible time (sec).

Boxplots for tested occurrence behaviours

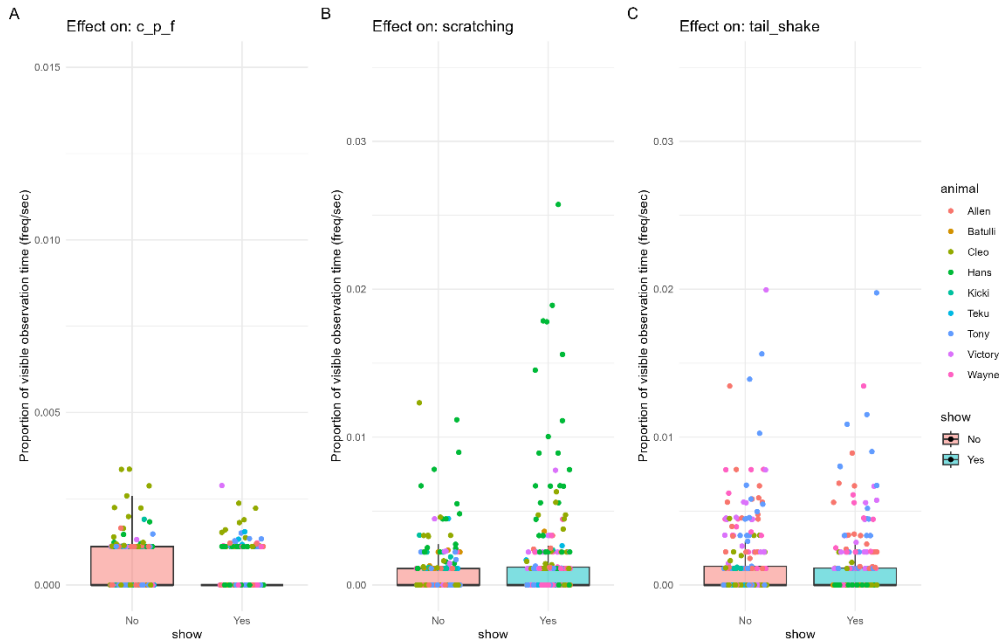


Figure 5: The boxplots for the effect of show on occurrence behaviours A) casting faeces (c_p_f), B) scratching and C) tail shake in proportion of visible time (freq/sec).

Behaviours that showed a numerical difference in median or 3rd quantile were tested using a Wilcoxon signed-rank test. Tests showed a significant difference ($\alpha = 0.05$) between SD and NSD for vigilance ($W = 5, p = 0.038$) where birds showed more vigilance on days with a show, but after correcting for multiple testing using the Benjamini-Hochberg correction, this significance did not hold ($p_{adj_BH} = 0.181$). No significant differences were detected for the other behaviours (See Table 4: Wilcoxon signed-rank test results for the difference between no-show days (NSD) and show days (SD), where every bird is its own control. **Table 4**).

Table 4: Wilcoxon signed-rank test results for the difference between no-show days (NSD) and show days (SD), where every bird is its own control. Median NSD and median SD are calculated as the median of the individual medians for all 9 individuals, representing the behaviour as a proportion of visible time. W represents the Wilcoxon signed-rank test statistic, p is the calculated p-value and p_adj_BH is the corrected p-value using a Benjamini-Hochberg correction.

Behaviour	N	Median NSD	Median SD	W	p	p_adj_BH
moving ¹	9	0.014	0.012	13	0.260	0.325
preening ¹	9	0.010	0.016	15	0.674	0.674
vigilance ¹	9	0.746	0.834	5	0.038	0.181
perching ¹	9	0	0	6	0.109	0.181
resting ¹	9	0	0	6	0.109	0.181
casting faeces ²	9	0	0	1	0.317	0.317
scratching ²	9	0	0	0	0.068	0.204
tail shake ²	9	0	0	9	0.144	0.216

¹ Median NSD and Median SD in seconds, ² Median NSD and Median SD in frequency/second.

Figure 6 and **Figure 7** show paired plots for respectively the tested continuous and occurrence behaviours, to give an idea how each animal changed the specific behaviour between SD and NSD. Batulli and Teku (SGHB, KD) moved more on SD compared to NSD (Figure 6A). Victory (Harris's hawk, KD) showed more preening on SD, while Batulli (SGHB, KD) and Allen (Harris's hawk, EP) showed less preening on SD (Figure 6B). All animals showed more vigilance on show days except for Hans (military macaw, KD) who showed less vigilance on SD (Figure 6C). Casting of faeces was less shown on SD by Cleo (lanner falcon, EP) (Figure 7A). Hans (military macaw, KD) showed the highest increase in scratching on SD (Figure 7B), and Victory (Harris's hawk, KD) showed the largest decrease in tail shakes on SD compared to the other animals (Figure 7C).

Paired plots for tested continuous behaviours

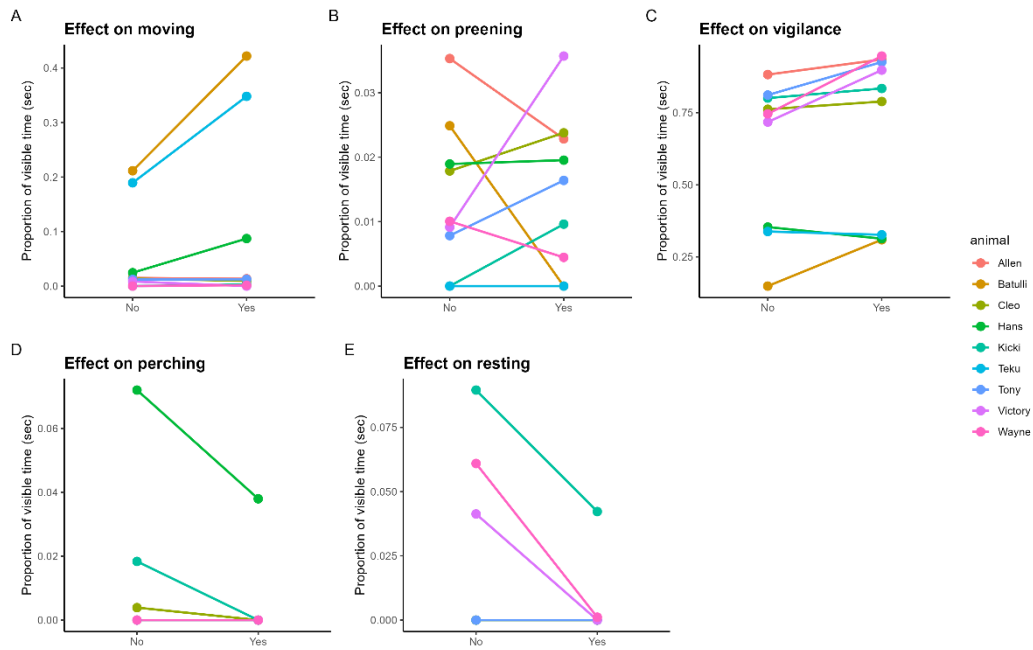


Figure 6: Paired plots for continuous behaviours A) moving, B) preening, C) vigilance, D) perching and E) resting. The lines represent how and how much the behaviour changes for each bird between show days (Yes) and no-show days (No) in proportion of visible time (sec).

Paired plots for tested occurrence behaviours

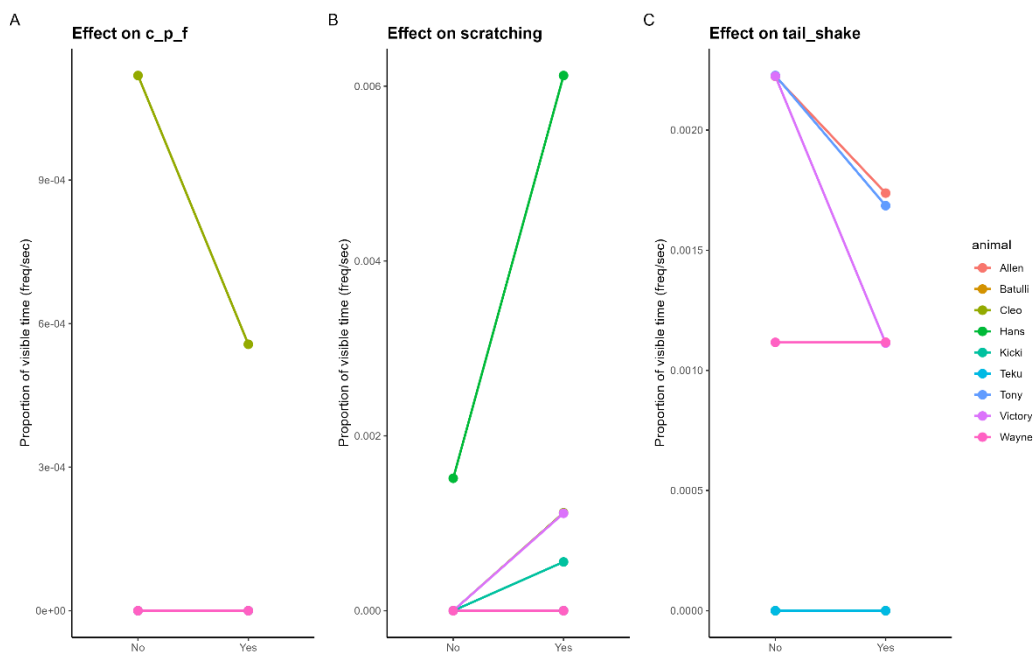


Figure 7: Paired plots for occurrence behaviours A) casting faeces (c_p_f), B) scratching and C) tail shake. The lines represent how and how much the behaviour changes for each bird between show days (Yes) and no-show days (No) in proportion of visible time (freq/sec).

When looking at the boxplots for individual animals some interesting observations were made. On SD Hans (military macaw, KD) showed more aggression (72 seconds in 9 sessions) and threatening behaviours (41 seconds in 8 sessions) than on NSD (51 seconds in 5 sessions and 11 seconds in 2 sessions for respectively aggression and threatening). He also showed more other behaviour (2255 seconds in 14 sessions) and more stress/alarm vocalizations (298 times in 16 sessions) on SD than on NSD (1525 seconds in 13 sessions and 160 times in 11 sessions for respectively other behaviour and stress/alarm vocalizations). This other behaviour was mainly hanging upside down from the mesh ceiling, which was often accompanied by the alarm vocalizations.

The SGHB (Teku and Batulli) were more often observed to pace on SD (2138 seconds in 11 sessions) than on NSD (1091 seconds in 2 sessions). Laying down and head tucked under the wing were only observed on NSD (7481 seconds in 18 sessions and 2657 seconds in 10 sessions for respectively laying down and head tucked under wing (all birds combined)).

3.2 Before show compared to after show

To check whether the show itself influenced behaviour, before show sessions and after show sessions were compared for all SD. After creating boxplots for all behaviours that were seen during observations, there were three continuous behaviours that showed a numerical difference in median between before show and after show. These were moving, preening and vigilance with a median of respectively 0.014, 0.017 and 0.876 (proportion per visible time (sec)) before show and 0.010, 0.008 and 0.803 (proportion per visible time (sec)) after show. The behaviours foraging and resting both had a median of zero on before show and after show, but showed a higher 3rd quantile after show, respectively 0.008 and 0.002 (proportion per visible time (sec)) compared to before show, which were both zero. See **Figure 8** for the boxplots of these continuous behaviours.

For the occurrence behaviours, the behaviours that showed a clear boxplot are flicking with head, rousling, scratching and tail shake. Although these behaviours all had a median of 0 (proportion per visible time (freq/sec)) on both before show and after show, there were differences in the 3rd quantile. Flicking with head had 3rd quantiles of 0.0011 for after show and 0.0013 for before show (proportion of visible time (freq/sec)). For rousling these were 0 for after show and 0.0011 for before show (proportion of visible time (freq/sec)). For scratching these were 0.0013 for after show and 0.0012 for before show (proportion of visible time (freq/sec)) and for tail shake these were 0.0011 for after show and 0.0022 for before show (proportion of visible time (freq/sec)). See **Figure 9** for the boxplots of these occurrence behaviours.

Boxplots for tested continuous behaviours

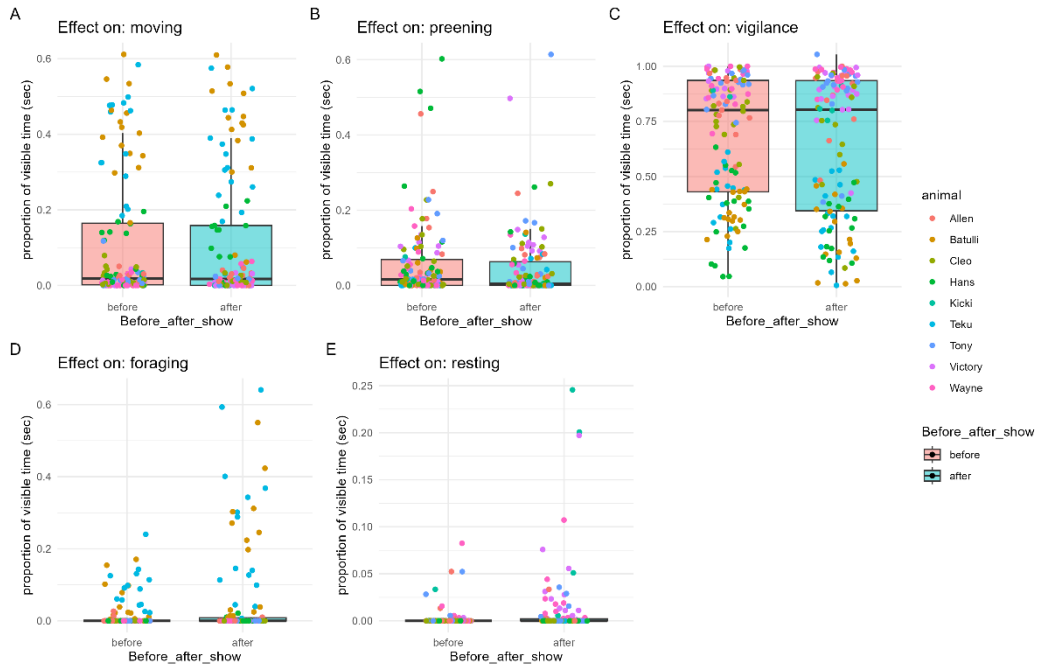


Figure 8: The boxplots for the effect of before and after show on continuous behaviours A) moving, B) preening, C) vigilance, D) perching and E) resting in proportion of visible time (sec).

Boxplots for tested occurrence behaviours

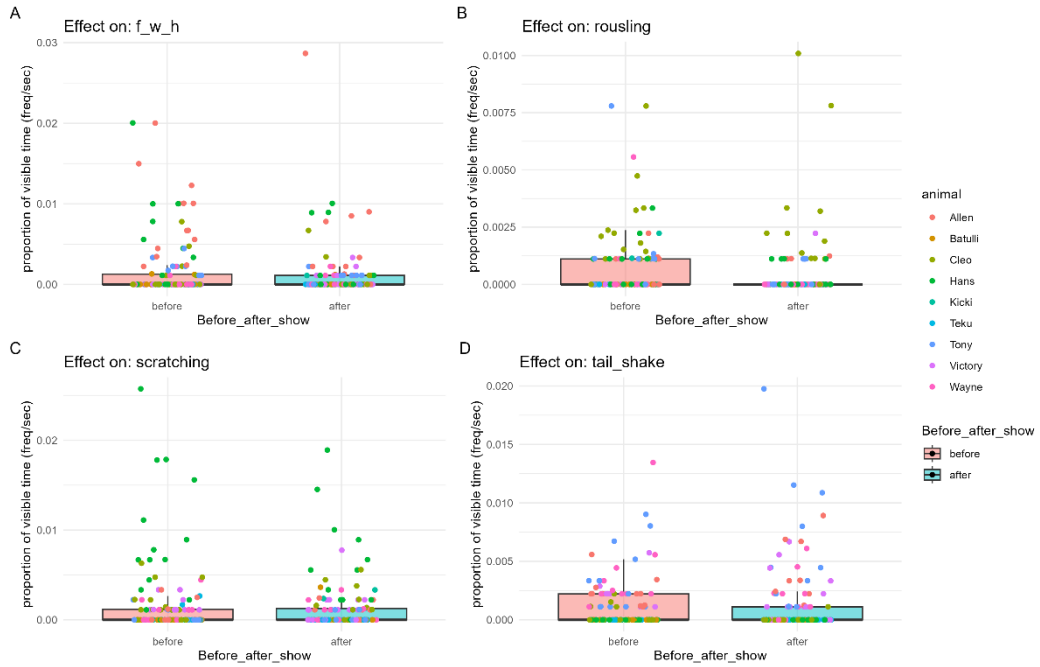


Figure 9: The boxplots for the effect of show on occurrence behaviours A) flicking with head (f_w_h), B) rousling, C) scratching and D) tail shake in proportion of visible time (freq/sec).

Behaviours that showed a numerical difference in median or 3rd quantile were tested using a Wilcoxon signed-rank test. Tests showed a marginal significant difference ($\alpha = 0.05$) between before show and after show for vigilance ($W = 5$, $p = 0.051$) where birds showed more vigilance before a show, but after correcting for multiple testing using the Benjamini-Hochberg correction, this significance did not hold ($p_{adj_BH} = 0.206$). No significant differences were detected for other behaviours (See **Table 5**).

Table 5: Wilcoxon signed-rank test results for the difference between after show and before show, where every bird is its own control. Median after show and median before show are calculated as the median of the individual medians for all 9 individuals, representing the behaviour as a proportion of visible time. W represents the Wilcoxon signed-rank test statistic, p is the calculated p -value and p_{adj_BH} is the corrected p -value using a Benjamini-Hochberg correction.

Behaviour	N	Median after show	Median before show	W	p	p_adj_BH
moving ¹	9	0.010	0.014	25	0.767	0.767
preening ¹	9	0.008	0.017	7	0.124	0.206
vigilance ¹	9	0.803	0.876	6	0.051	0.206
foraging ¹	9	0	0	3	0.180	0.225
resting ¹	9	0	0	6	0.109	0.206
flicking with head ²	9	0	0	0	0.180	0.719
rousling ²	9	0	0	1	0.655	0.873
scratching ²	9	0	0	5	1	1
tail shake ²	9	0	0	3	0.465	0.873

¹ Median after show and Median before show in seconds, ² Median after show and Median before show in frequency/second.

Figure 10 and **Figure 11** show paired plots for respectively the tested continuous and occurrence behaviours, to give an idea how each animal changed specific behaviour before and after show. Hans (military macaw, KD) and Batulli (SGHB, KD) increased moving after show compared to before show, while Teku (SGHB, KD) decreased his movement after show (Figure 10A). Most birds showed more preening before show, except for Cleo (lanner falcon, EP) and Allen (Harris's hawk, EP) (Figure 10B). Foraging was mainly showed by SGHB, who both showed more foraging after show (Figure 10D). Kicki (lager falcon, KD) showed a large increase in resting after show (Figure 10E). It must be noted that this median is based on only six observation sessions, two before show and four after show.

Paired plots for tested continuous behaviours

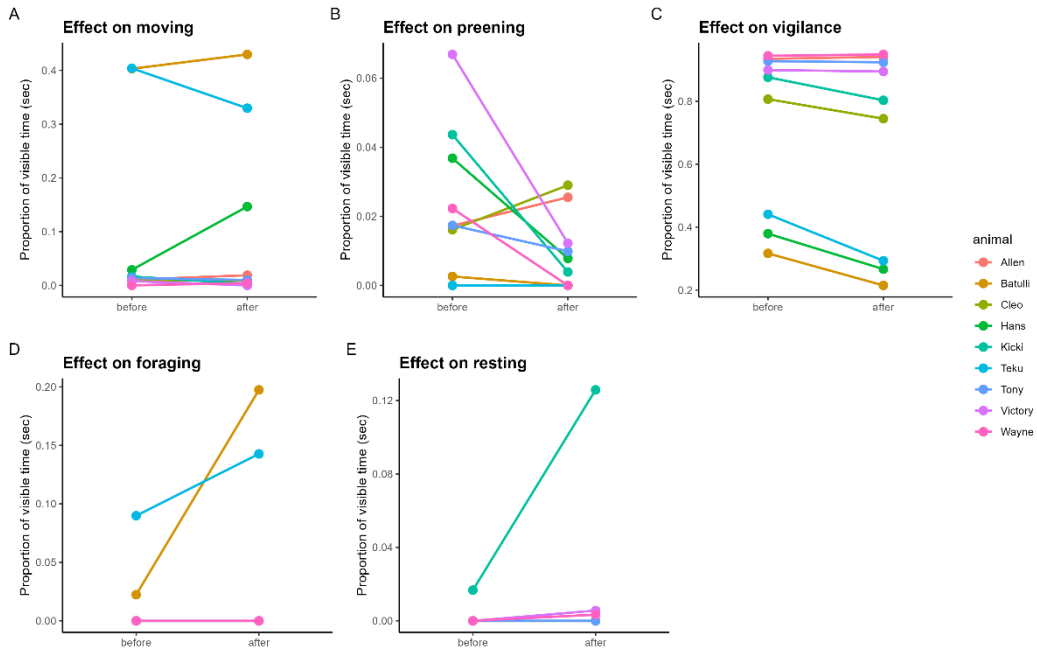


Figure 10: Paired plots for A) moving, B) preening, C) vigilance, D) foraging and E) resting. The lines represent how and how much the behaviour changes for each bird between before show (before) and after show (after) in proportion of visible time (sec).

Paired plots for tested occurrence behaviours

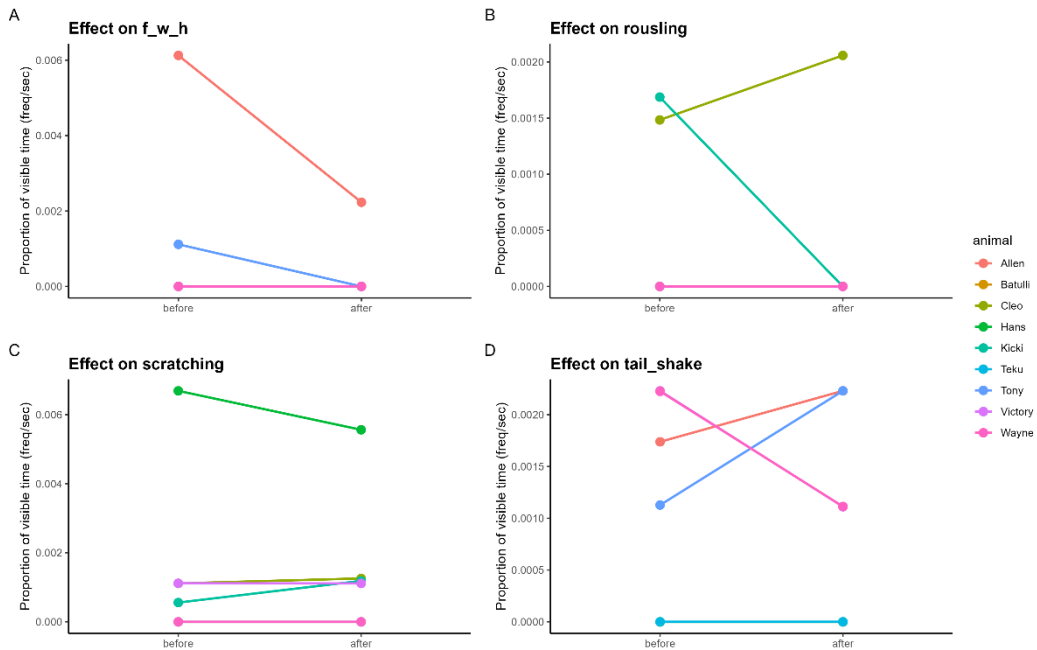


Figure 11: Paired plots for A) flicking with head (f_w_h), B) rousling, C) scratching and D) tail shake. The lines represent how and how much the behaviour changes for each bird between before show (before) and after show (after) in proportion of visible time (freq/sec).

Allen (Harris's hawk, EP) showed the largest decrease in flicking with his head after show (Figure 11A). Kicki (laggar falcon, KD) showed a decrease in rousling after show, but again she just had six show observations, while Cleo (lanner falcon, EP) increased her rousling behaviour after show (Figure 11B). Wayne (Harris's hawk, KD) decreased his tail shakes after show, while Allen and Tony (both Harris's hawk, EP) increased their tail shakes after show (Figure 11D).

When looking at the boxplots for the individual animals some interesting observations were made. Hans (military macaw, KD) showed more other behaviour before show (1724 seconds in 8 sessions) than after show (531 seconds in 6 sessions) and more stress/alarm vocalizations before show (230 times in 9 sessions) than after show (68 times in 7 sessions after show). This other behaviour was mainly hanging upside down from the mesh ceiling, which was often accompanied by the alarm vocalizations.

The SGHB (KD) were more often observed to pace before show (1927 seconds in 10 sessions) than after show (211 seconds in 2 sessions). Tony (Harris's hawk, EP) showed more bating (flying uncontrolled into the mesh walls), before show (46 seconds in 4 sessions) than after show (8 seconds in 2 sessions). Cleo (lanner falcon, EP) showed more flapping before show (283 seconds in 8 sessions) than after show (12 seconds in 5 sessions).

3.3 Summer aviary compared to winter aviary

Since in KD birds are housed in completely different aviaries between winter and summer, comparisons are also made between winter and summer aviaries, but only for these birds. This to investigate if any differences between NSD and SD can also be contributed to differences between aviaries, since SD only happen when birds are in their summer aviary.

Boxplots showed a numerical difference between aviaries for foraging (median 0 and 0, 3rd quantile 0 and 0.043 (proportion of visible time (sec)) for respectively winter and summer aviary), moving (median 0 and 0.050 (proportion of visible time (sec)) for respectively winter and summer aviary), vigilance (median 0.366 and 0.480 (proportion of visible time (sec)) for respectively winter and summer aviary), flicking with head (median 0 and 0, 3rd quantile 0.001 and 0 (proportion of visible time (freq/sec)) for respectively winter and summer aviary) and scratching (median 0 and 0, 3rd quantile 0.0011 and 0.0014 (proportion of visible time (freq/sec)) for respectively winter and summer aviary) (see **Figure 12**).

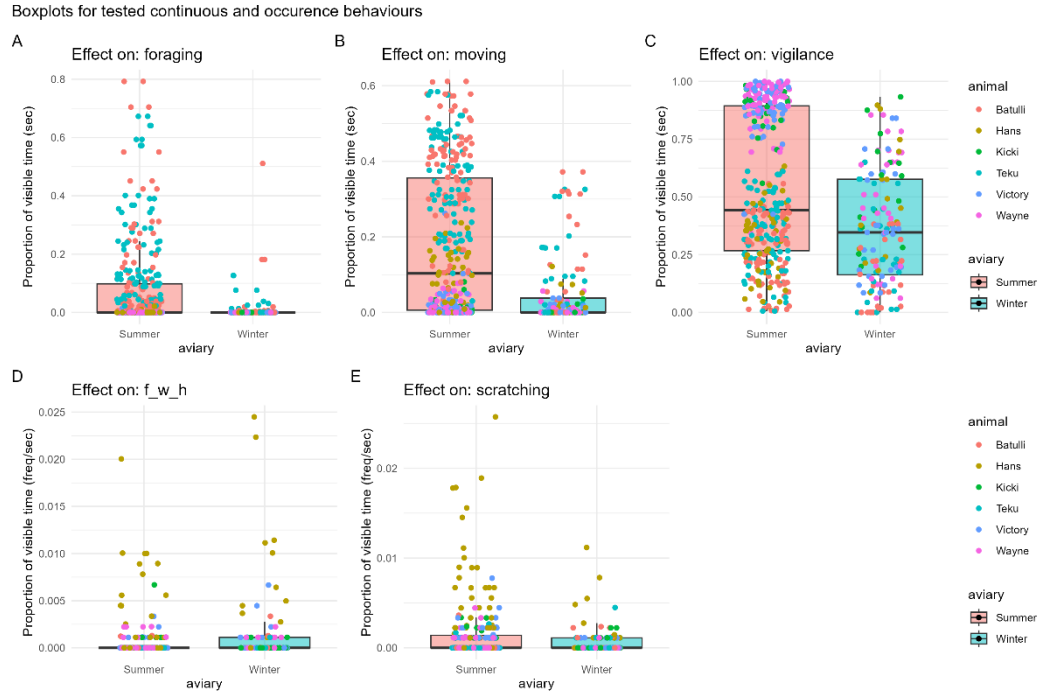


Figure 12: The boxplots for the effect of summer and winter aviary on continuous behaviours A) foraging, B) moving, C) vigilance in proportion of visible time (sec) and for occurrence behaviours D) flicking with head (f_w_h) and E) scratching in proportion of visible time (freq/sec).

Wilcoxon signed-rank tests showed a significant difference ($\alpha = 0.05$) between winter and summer aviary for moving ($W = 3$, $p = 0.043$) where birds showed more movement in their summer aviaries, but after correcting for multiple testing using the Benjamini-Hochberg correction, this significance did not hold ($p_{adj_BH} = 0.112$). No significant differences were detected for other behaviours (see Table 6).

Figure 13 shows paired plots for these behaviours, to see how each animal changed its behaviour between aviaries. Foraging was mainly displayed by SGHB (KD), who showed more foraging in summer aviary than in winter aviary (Figure 13A). SGHB (KD) showed more movement in summer aviary compared to winter aviary (Figure 13B). All animals showed more vigilant behaviour in summer aviaries, except for Hans (military macaw, KD) who showed more vigilance in winter aviary compared to summer aviary (Figure 13C). Flicking with head was mainly done by Hans (military macaw, KD) who showed more often a flick of his head in winter aviary compared to summer aviary (Figure 13D). Scratching was also more prevalent in summer aviaries, where Hans (military macaw, KD) showed the largest increase between summer aviary and winter aviary (Figure 13E).

Table 6: Wilcoxon signed-rank test results for the difference between summer and winter aviary, where every bird is its own control. Median Summer and median Winter are calculated as the median of the individual medians for all 6 Kolmården's individuals, representing the behaviour as a proportion of visible time. *W* represents the Wilcoxon signed-rank test statistic, *p* is the calculated *p*-value and *p_adj_BH* is the corrected *p*-value using a Benjamini-Hochberg correction.

Behaviour	N	Median Summer	Median Winter	W	p	p_adj_BH
vigilance ¹	6	0.617	0.399	19	0.075	0.112
moving ¹	6	0.041	0.006	15	0.043	0.112
foraging ¹	6	0	0	3	0.180	0.180
f_w_h ²	6	0	0	0	0.317	0.317
scratching ²	6	0.001	0	6	0.109	0.218

¹ Median Summer and Median Winter in seconds, ² Median Summer and Median Winter in frequency/second.

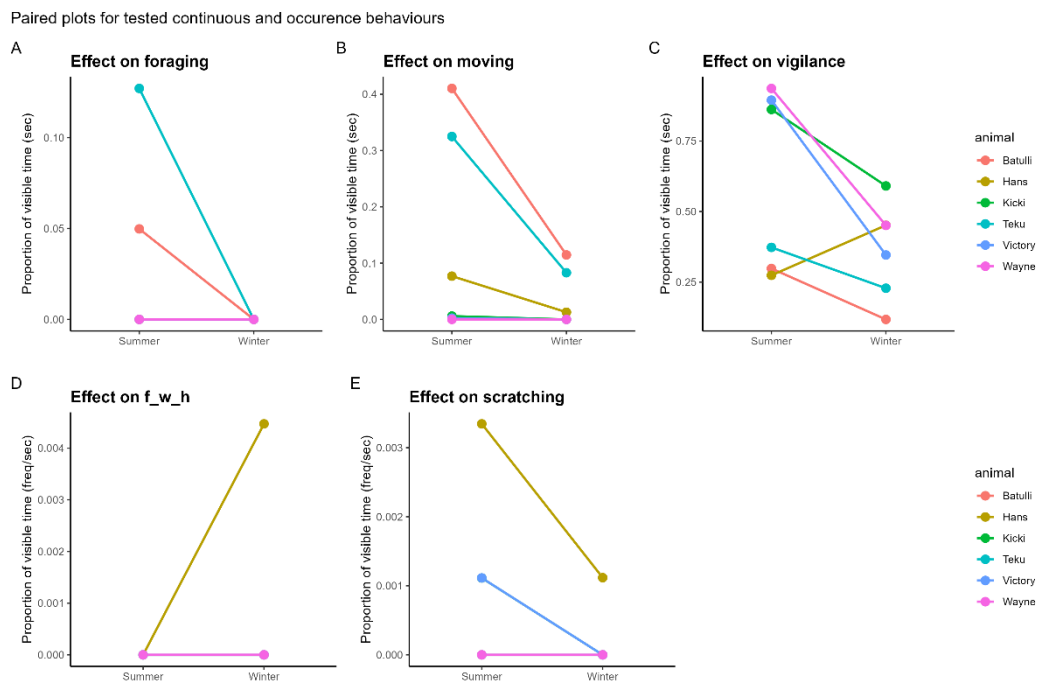


Figure 13: Paired plots for A) foraging, B) moving and C) vigilance in proportion of visible time (sec) and D) flicking with head (f_w_h) and E) scratching in proportion of visible time (freq/sec). The lines represent how and how much the behaviour changes for each bird between winter aviary (winter) and summer aviary (summer) for the birds in Kolmårdens Djurpark.

When looking at the individual animals it is seen that Hans (military macaw, KD) shows more aggression and threatening behaviour in summer aviary (110 seconds in 12 sessions and 46 seconds in 9 sessions respectively) compared to winter aviary (13 seconds in 2 sessions and 6 seconds in 1 session respectively) and more

allogrooming in winter aviary (838 seconds in 8 sessions) compared to summer aviary (636 seconds in 7 sessions).

Other behaviour and stress/alarm calls increase for Hans (military macaw, KD) in summer aviary (3691 seconds in 24 sessions and 454 times in 26 sessions respectively) compared to winter aviary (89 seconds in 3 sessions and 4 times in 1 session respectively). This other behaviour was mainly hanging upside down from the mesh ceiling, which was often accompanied by the alarm vocalizations.

Victory (Harris's hawk, KD) and Hans (military macaw, KD) looked out for trainers more often in summer aviary (361 seconds in 11 sessions and 529 seconds in 14 sessions respectively for Victory and Hans) compared to winter aviary (67 seconds in 2 sessions and 0 seconds or sessions for respectively Victory and Hans).

4. Discussion

A sign of good welfare is the performance of natural behaviours in appropriate amounts, although appropriate amounts are hard to define and not all natural behaviours promote better welfare in captive environments (Hill & Broom 2009; Kelly 2025; Kelly et al. 2025). Next to that, not much is known about daily activity patterns of many animal species in the wild (Kelly 2025). Another welfare measurement often used is inactive behaviour, where more inactive behaviour could be related to decreased welfare in captive settings (Tallo-Parra et al. 2023), since this could be a sign of apathy or boredom (Manteca et al. 2016). For different animal species a different amount of inactive behaviour can be described as normal. Harris's hawks and falcons perch for approximately 80-95% of their day in nature (Satander et al. (2015); Hadjikyriakou et al. 2020), while parrots and SGHB are usually more active, parrots forage 40-60% of their day (Bays et al. 2006; Beekmans et al. 2023) and SGHB walk approximately 70% of their day, mainly to forage (Kemp & Kemp 1980).

4.1 Show days compared to no-show days

In this study vigilance is the most observed behaviour. Here vigilance was described as 'a bird is actively looking for a stimulus in the environment, whereby the head is directed towards and the eyes fixed on a stimulus, or the head is going from left to right as if to look for something'. Vigilance is used by animals to detect threats and is often related to predation risk, group size, body mass and environmental variables (Beauchamp 2010; Ahmed & Urfi 2024). Movements of the head that are used to detect threats can also be performed as part of foraging behaviour, especially for birds that forage from a perching position (Andersson et al. 2009; O'Rourke et al. 2010). Vigilance as part of foraging and detecting threats can thus be described as active behaviour even though it is often displayed when sitting still. In the above-mentioned studies on Harris's hawks and falcons (Satander et al. (2015); Hadjikyriakou et al. 2020), no difference is made between perching and not moving the head and perching and moving the head, being vigilant, this could potentially mean that birds in those studies are vigilant for up to 95% of their day.

On show days birds showed significantly, before adjusting for multiple hypotheses testing, more vigilance behaviour than on no-show days. An increase in vigilance in this study on SD could thus potentially be seen as an increase in active and natural behaviour. Next to that, inactive behaviours resting, perching, laying down and head stuck under wing numerically decreased or did not occur on SD. Furthermore, a numerical increase in moving and preening is seen on SD.

This could indicate that animals showed more active and natural behaviours on SD, thus indicating improved welfare on SD.

On the other hand, for some individuals, abnormal behaviours increased. Pacing was increased on SD for the SGHB's (KD) and hanging upside down combined with loud stress/alarm vocalizations was increased on SD for the military macaw (KD). These behaviours could be a sign of anticipatory behaviour instead of being truly abnormal, meaning occurring without a reason (Mason 2006). Anticipatory behaviour is behaviour that animals express when they expect a reward based on environmental cues they receive (Anderson et al. 2020). Anticipatory behaviour is said to be related to welfare, since animals with lower welfare are more sensitive to rewards and will thus show more anticipatory behaviour (Anderson et al. 2020). But it is also mentioned that anticipatory behaviour shows that an animal is looking forward to what is coming, is motivated for an expected event, especially when the event is a very predictable event that can provide rewards (Clegg et al. 2018; Acaralp-Rehnberg et al. 2020; Cooper-Rogers et al. 2026a), requirements that are met by a daily scheduled show. Anticipatory behaviour itself can give, although temporary, a moment of good welfare (Watters 2014). Thus, when birds are looking forward to a show or any part of a show, like food rewards or interaction with trainers, then anticipatory behaviour can be a sign of positive welfare.

However, when the reward is not delivered or delivered late, frustration can occur which may be expressed by similar behaviours (Anderson et al. 2020). Whether a behaviour is anticipatory, is stereotypical or is a sign of frustration depends on different factors such as, how does the animal respond to the environment before and during the behaviour, when does the behaviour occur, are there any cues to trigger the behaviour and how much time is passing between these cues and the actual reward (Watters 2014; Anderson et al. 2020). Since pacing and hanging upside down combined with screaming were most prevalent on SD, it can be expected that it is related to all the environmental cues associated with SD, like staff, music, visitors, and thus be anticipatory. Conversely, the military macaw also showed more aggression and threatening behaviours on SD. Frustration of uncontrollable rewards can cause aggression (Haskell et al. 2004), indicating that his anticipatory behaviour could be escalating into frustration.

For behaviour to be anticipatory it is important when the behaviour occurs. Therefore, a comparison was made between before and after show (see **4.2 Before show compared to after show**) to investigate whether the behaviour is anticipatory or not.

Some of the occurrence behaviours like scratching and tail shakes showed a numerical increase and decrease respectively between SD and NSD. A tail shake is a behaviour that is described by Jenner & Lewis (2024) as a form of grooming or a method of re-balance/movement and it shows a relaxed and comfortable bird.

Scratching is part of the maintenance repertoire and occurs during preening (Goodman et al. 2020), but it may also function as a displacement behaviour (Buckley & Semple 2012). Displacement behaviours are behaviours that animals display when having an internal conflict, a form of stress and are often behaviours that are part of the maintenance repertoire (Breed & Moore 2016a). If animals show high rates of displacement behaviours, it can be assumed that they have more negative emotional states and a change in environment could be beneficial (Breed & Moore 2016a). Internal conflict or frustration can occur when birds do not know how to get rewards they are anticipating (Haskell et al. 2004), which could result in performing anticipatory or displacement behaviour. An increase in scratching on SD, mainly for the military macaw, could be a sign of frustration and thus a reduction of welfare, especially if the behaviour occurred outside of preening episodes. If tail shakes are a sign of comfortable animals, a decrease in tail shakes on SD could mean that the animals are less comfortable on these days. But if performed as displacement behaviours on NSD, it could mean an increase in welfare on SD. Since this study did not specifically focus on these behaviours and therefore it is not noted whether these behaviours are displacement behaviours or a normal part of the preening routine, it cannot be concluded from this study if changes in these behaviours have an influence on animal welfare.

4.2 Before show compared to after show

To get a better understanding of the actual influence of show on any differences in behaviour between SD and NSD, comparisons are made between before and after show on SD.

Before show birds showed significantly, before adjusting for multiple hypotheses testing, more vigilance behaviour than after show. Vigilance is described as looking out for a stimulus (Beauchamp 2010; O'Rourke et al. 2010), this stimulus could also be a trainer, or an opportunity for a reward. In that case, vigilance could be an anticipatory behaviour. Since looking out for trainer and vigilance are very similar in their appearance and occurrence mostly depends on the environment, it was sometimes hard to distinguish between the two in observations.

Pacing and hanging upside down combined with loud stress/alarm vocalizations numerically decreased after show. Bating and flapping are not shown often but they do decrease after show. These behaviours can both be seen as anticipatory behaviours, since they are performed when a bird wants to fly towards something, often a trainer or food. Flapping and bating are related to stress for the animal (Jenner & Lewis 2024), which anticipatory behaviours can also be. A reduction in all these behaviours after show suggests that they are indeed anticipatory and not abnormal behaviours, thus indicating that the show

might have a positive influence on welfare (Clegg et al. 2018; Acaralp-Rehnberg et al. 2020; Cooper-Rogers et al. 2026a).

When concluding that anticipatory behaviour is beneficial for welfare, it is assumed that birds are looking forward to the show and the potential it has for gaining rewards. But why are animals eager to gain these rewards, and what rewards are they eager for? As mentioned, in free flying birds weight management is still a very important tool, to ensure participation and safety of the birds. Anticipatory behaviour increases when an animal has lower welfare (Anderson et al. 2020), and being on flying weight might be a reduction in welfare, since birds might feel hungry. The weight for some birds was approximately up to 21% lower in P2 and P3 than in P1 when flying weight was not maintained. This could imply that anticipatory behaviours are increasing because of lower weights or a higher motivation for food. That said, birds showing the most anticipatory behaviour, the SGHB's and military macaw in KD, did not show such substantial differences between weights in the different periods. These differences were approximately 11.96% for SGHB Batulli, 7.97% for SGHB Teku and 0.33% for military macaw Hans, suggesting that food might not be the main motivator. Another potential risk of weight management on animal welfare might be that being on flying weight, thus wanting to look for food, but not being able to get the benefit of flying or foraging, as is the case on NSD in P2, could cause frustration.

Other rewards birds might be eager for when participating in a show are the possibility of flying (Massen et al. 2022), the challenge of training (Fernandez 2022) or the pleasure of social interactions with staff (Brando et al. 2023). This could suggest that an increase in anticipatory behaviour on SD means that they have a lack of these opportunities on NSD. Although this study did not focus on what could be a rewarding aspect of show, an indication that training or interaction with staff is important can be found in the fact that Hans (military macaw, KD) showed more allogrooming before show, compared to after show. This might be linked to the behind-the-scenes tours that occurred in summer. For these tours Hans was taken out of his aviary and trained in front of the guests while receiving a reward. This could, at least temporarily, reduce the need to express anticipatory behaviours, since he was already trained, leaving more time for other more natural behaviours, like allogrooming. The anticipatory behaviours he did show, could have occurred later, when more cues for commencing of the first show emerged or after the first show, since he was often flown in the second show.

Rousling and tail shakes seem to occur more often before show. These behaviours can be linked to a bird's preening routine (Jenner & Lewis 2024), and since there is also a numerical increase in preening observed before show, this could be related to each other. Preening is a natural behaviour, which birds adopt to clean feathers from parasites (Goodman et al. 2020), but preening can escalate

to feather pecking when a bird is not challenged (De Almeida et al. 2018). An increase in preening before show can therefore possibly be caused by a lack of challenge or a presence of frustration. These results are different than those observed by Cooper-Rogers et al. (2026a), who reported more grooming after show, explaining it as an increase in natural behaviour after show. The difference in results might be explained by differences in species, where different species spent different amounts of time on preening (Goodman et al. 2020).

After show there is a numerical increase in foraging and resting. These are natural behaviours that are often linked to a positive state of mind, especially when they are reflective of the species' wild counterpart (Tallo-Parra et al. 2023; Kelly 2025), this would thus suggest that after show welfare is enhanced.

Moving is observed more before show. Animals change position, to find better circumstances (Breed & Moore 2016b), thus suggesting that before show animals are looking for better circumstances. But there are large differences between individuals, even individuals of the same species living in the same aviary under the same circumstances, which makes it hard to conclude if this change in behaviour has a direct influence on welfare or is related to participation in show.

4.3 Summer aviary compared to winter aviary

In Kolmårdens Djurpark the birds are moved to different aviaries in winter, to provide them with more suitable temperatures, according to their natural habitats, during the colder winters. These aviaries show large differences from summer aviaries, which can mean that some of the differences in behaviour between SD and NSD could be explained by aviary, especially since all SD occurred when birds were in their summer aviary.

Moving showed a significant, before adjusting for multiple hypotheses testing, difference between summer and winter aviary indicating that the difference in moving between SD and NSD could at least partly be explained by the difference in aviary. This could not be controlled for during the analysis when comparing NSD and SD. Moving is mainly displayed by the SGHB as part of the foraging behavioural repertoire (Kemp & Kemp 1980). Because the winter aviaries must be heated, they are completely indoors, while summer aviaries are only closed by mesh. Therefore, summer aviaries provide more opportunities to find insects and other possible food sources, resulting in more stimulus to move and forage.

Vigilance showed a numerical increase in summer aviaries, although not significantly it could still indicate that not only participation in a show had an influence on this behaviour but also housing situations of the birds. Since winter aviaries are indoors, they offer less stimuli to look at for the birds, possibly explaining the reduction of vigilance in winter aviaries.

Another difference between summer and winter aviary was the amount of looking out for trainers, although not enough to be tested for significance. Winter

aviaries are located at a different location in the park. Birds could only see trainers, when they were cleaning, feeding and training the birds in the morning or when they performed their last afternoon check of the birds. In between, trainers were not visible to the birds, since they were at another part of the zoo. This resulted in less opportunities to look out for trainers in winter aviaries than in summer, when birds could see trainers taking care of the other animals in the department.

Hans (military macaw, KD) showed more aggression in summer and more allogrooming in winter aviary. The macaws stayed in their inside enclosure during winter and gained additional access to their outside enclosure during summer. Since differences between winter and summer aviary are not so distinctive for this macaw, it may be suggested that the difference in these behaviours does seem to be related more to SD and NSD than to aviary. In summer, when there are shows, this bird shows more anticipatory behaviour, potentially escalating to frustration (see **4.1 Show days compared to no-show days**), which could explain the higher occurrence of aggressive behaviours. In winter, when there are no shows, there is hardly any anticipatory behaviour, which results in more time for other behaviours such as allogrooming his partner.

These differences between winter and summer aviary indicate that housing does contribute to behaviour changes and thus welfare as is suggested by Rose & Hickey (2025). Therefore, housing should not be compromised in any way, whether a bird participates in a show or not.

4.4 Limitations and future research

There were some limitations in the study design. For one, the number of individuals and observations that could be made were rather small. With only nine animals from five different species in two different parks, the results cannot be extrapolated to birds participating in shows in other zoological institutions or to other species. Both parks experienced rather substantial changes right before commencing observations, namely a new show format at KD and a significant turnover of personnel at EP, neither of which could be anticipated beforehand. These events may have influenced the final results, as these transitions may have led to potential stress and altered routines for staff, which in turn could have had an influence on bird welfare (Hosey 2008; Brando et al. 2023). Conducting this research over several seasons could reduce the influence of these external factors. Furthermore, using study subjects in another country provided some logistic challenges. Getting necessary information on show times, show participation and the working and positioning of the cameras proved more difficult than acquiring this information from study subjects here in Sweden, although it did provide a larger research sample. The very detailed ethogram and continuous sampling made it sometimes difficult to always keep up with the fast behavioural changes

of some birds, especially when observing two individuals at the same time. Categorizing behaviours could make it easier to observe but would also limit detailed observations and analysis.

Another challenge in this study was the difference in species, which is illustrated in the paired plots. For instance, where almost all animals increased vigilance on SD, the military macaw decreased vigilance on SD. Differences between species can be seen, but also between individuals. For example, SGHB Teku (KD) moved more after show, while SGHB Batulli (KD) moved less after show, even though they lived in the same aviary and received the same amount of training and enrichment. This stresses the importance of looking at welfare on an individual basis (Watters & Powell 2012; Powell 2025). For some species participating in a show and living in a zoo might reduce their welfare, while others might be better suited to adjust to living in captivity (Mellor et al. 2021). Species, but also individuals should be selected for participation in shows based on species and individual characteristics (Martin et al. 2024). Since natural behavioural repertoires differ a lot between the different species studied, concluding on a change in animal welfare based on behavioural observations alone is difficult. Future research could focus on just one or two species and try to combine data from several zoological institutions and several welfare indicators to see how welfare changes, for a single species when participating in shows.

This study only looked at behavioural differences, due to time and budgetary issues, but including other indicators could give a more detailed evaluation of welfare. For instance, glucocorticoid hormones can be used to give an idea about affective state, since they are released in response to stress (McEwen 2007), indicating that lower levels mean a positive affective state. It is possible to reliably measure glucocorticoid hormones in faeces (Munteanu et al. 2017; De Almeida et al. 2018), and this can thus be a non-invasive way to get physiological data on affective state. Although it should be mentioned that faecal glucocorticoid hormones give an estimate of affective state over time, rather than the affective state at a specific moment, due to its gradual accumulation in faeces and to the delay in corticosterone metabolism (Munteanu et al. 2017). Another possibility would be the use of cognitive bias tasks (Paul et al. 2005). In a cognitive bias task, a bird could be trained to measure how optimistically or pessimistically it will respond to an ambivalent cue, which could then provide information about the affective state of this bird (Appleby et al. 2018; Massen et al. 2022; Siewert et al. 2025). Since birds participating in shows are already used to training, this could be a relatively easy approach. Another option would be the use of Qualitative Behavioural Analyses, to give additional information on bird welfare (Wemelsfelder et al. 2001; Tallo-Parra et al. 2023). Trained observers assess animal emotions based on the animal as a whole in combination with their surroundings (Wemelsfelder et al. 2001). Zookeepers do this on a regular basis

and their daily records can be used as a form of qualitative behaviour analysis, giving easy, cheap and often reliable welfare assessments (Meagher 2009; Whitham & Wielebnowski 2009; Tallo-Parra et al. 2023). By combining behavioural, physiological and physical measures a more comprehensive welfare assessment could be generated (Hill & Broom 2009; Manteca et al. 2016; Appleby et al. 2018).

Anticipatory behaviour can indicate a motivation to participate in the show, but as questioned earlier in this report, what is it birds are motivated for, food, interaction with staff, flying, mental stimulation in the form of training or maybe something else? Further research could be directed at this question. If it is known what birds are mostly motivated for, this can then be used to enhance welfare of birds when there are no shows or for birds that live in aviaries without being able to participate in a show at all. This research should be conducted on species level, since, as stated before, every species may respond differently to shows.

Differences in season, where in winter birds do not participate in shows and in summer they participate almost every day, resulted in different husbandry routines in these zoos. In winter, birds were housed almost as aviary birds, with just one training opportunity a day. While in summer they could be classified as show birds, who received multiple training and flying opportunities a day. Future research could focus on if and why there are differences in husbandry of aviary birds compared to show birds. Since it has been documented that training can be enriching (Fernandez 2022), that flying enhances health (Brereton et al. 2025) and that enrichment can improve welfare (Brereton et al. 2021; Decker et al. 2023), all zoo-housed birds should be able to receive these opportunities. Shows can add to an already good welfare, however being in a show or not in a show should not be used as an excuse for lowering housing standards or husbandry practices. Future research should help in enhancing welfare for all birds housed in zoos, not just for ambassador birds.

4.5 Significance

Zoos have a legal and moral obligation to provide animals with the best possible welfare, and excellent animal welfare is necessary to fulfil the educational and conservational functions of a zoo (Tallo-Parra et al. 2023). Participation in a show can be a factor in achieving that excellent welfare, assuming the right species and individuals are chosen. Even though birds are the most commonly used taxa in demonstrations (D'Cruze et al. 2019), there is a lack of studies on both the impact of shows on animal welfare and of zoo bird welfare in general (Binding et al. 2020; Woods et al. 2022), stressing the importance of studies that look at bird welfare of birds engaging in shows. When zoological institutions want to continue using shows and educational presentations as a means of educating visitors on nature and species conservation, which have been shown to be affective (Povey &

Rios 2002; Visscher et al. 2009; Godinez & Fernandez 2019; Spooner et al. 2021; Lyon et al. 2024), empirical data should be gathered on whether shows impair, enhance or are neutral to bird welfare, since animal welfare should always be a zoos priority. Empirical data is essential for zoos to make evidence-based decisions regarding the continuation of shows, and this study contributes to this empirical data.

Ethically, utilizing live animal shows as a form of education in modern zoos remains an ongoing debate. From a deontological animal rights point of view, any form of using animals is fundamentally wrong, regardless of potential benefits for in-situ conservation or wild populations (Comstock & Engel 2016). On the other hand, a utilitarian framework will approve of shows, when they generate a net positive outcome, especially when balancing potential individual animal welfare costs against benefits in conservation awareness, biodiversity education, and visitor satisfaction (Bostock 1993), provided that the best possible animal welfare is ensured (Fernandez et al. 2009; Mellor et al. 2020). Research, such as this, that determines whether shows enhance, are neutral to or decrease individual animal welfare are critical and can help providing arguments in this debate.

5. Conclusion

This study aimed to find out if there is an effect of shows on the welfare of birds participating in these shows. It can be concluded that participation in shows does result in a difference in behaviours shown by the birds in this study. They displayed more active and natural behaviours on show days, which would indicate an increase in welfare. But this conclusion must be taken carefully since it depended heavily on bird species and even on individual. Some species showed a higher prevalence of abnormal behaviours and behaviours that could be displacement behaviours. These behaviours seemed anticipatory indicating a positive state when the opportunity arises to fly in the show, but these anticipatory behaviours can escalate into frustration and thus potentially lowering the welfare of birds involved. Research on the intrinsic motivation for participating in shows could help enhance welfare of all zoo-housed birds, since then these motivations could be fulfilled with husbandry practices other than shows.

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Popular science summary

To educate visitors on species and nature conservation zoos often use shows or educational presentations. Even though birds are often part of these shows, not much is known on the impact of these shows on the welfare of birds. Shows can influence bird welfare through multiple factors. For one, the number of visitors that visit the show can influence welfare. Next to that, the training methods used to participate in the show or the interactions between zookeepers and birds have an influence on welfare. Shows can also be a form of enrichment and sometimes housing is different for birds that participate in a show, compared to birds that do not, possibly influencing animal welfare.

This study looked at the behaviour of nine birds of five different species in two different zoos to see whether their behaviour changed on days birds participated in a show and days they did not participate. To further investigate the effect of show, behaviour was also compared between before and after show. Behavioural changes can be used as an indicator for animal welfare.

Birds showed an increase in active and natural behaviours, like vigilance, moving and preening on show days, compared to no-show days, indicating better welfare. Abnormal behaviours, like pacing and hanging upside down while screaming also increased on show days. The comparison between before and after show, suggests that these behaviours were mainly anticipatory, since there was a decrease of these behaviours after show. Anticipatory behaviour can be positive, since a bird shows this behaviour when it is looking forward to something. On the other hand, anticipatory behaviours can escalate into frustration, when the anticipated event is not happening, and then cause a decrease in welfare. There seemed to be a difference in results between different species. Some species showed more anticipatory behaviours and others showed more active and natural behaviour in the form of vigilance and foraging. But there was also one bird that showed signs of frustration, when he could not participate in a show or training.

Overall, this study suggests that bird shows can have a neutral to positive effect on bird welfare, but it showed also that it depends on bird species or even individuals. To further improve the welfare of zoo-housed birds, future research could focus on why different species want to participate in a show, so these motivations can also be addressed through other means than a show.

Keywords: Animal welfare, birds, shows, educational presentation, anticipatory behaviour, natural behaviour, zoos

Appendix 1

Ethogram based on literature (Wickert 2020; Brereton et al. 2021; Jenner & Lewis 2024; Marcuk et al. 2025), information from experts and preliminary observations. Behaviours are divided into behavioural categories. All behaviours are state behaviours, except behaviours marked with an * which are event behaviours.

Behaviour	Description
Active behaviour	
Moving	The bird moves from one spot to another in a controlled manner; the bird may turn and look at the new spot for a moment before moving to it. This movement can be done by either walking, hopping, climbing or flying. Distance is not a factor.
Bating	The bird flies off its current perch or glove in a sudden and uncontrolled manner - it may not proceed directly to a new perch but instead may fly around the enclosure and may land on the ground or in the mesh.
Interacting with objects in enclosure	The bird is interacting with an item/object in its enclosure. This might be enrichment put in by keepers or part of the enclosure/furniture.
Hitting with beak on object	Hitting with beak on object, whether enrichment or part of the enclosure.
Nest building	The bird is putting material on or around its nest.
Moving with food in beak	Bird is moving around with food in its beak.
Foraging	The bird is actively searching for food, by walking on the ground and using its beak or paws to displace leaves etc. The head is bent downwards.
Inactive behaviour	
Perching	The bird is standing upright, both feet contacting the perch, body sleek and straight and remains in one place, head neither low nor high and still for at least 3 seconds, wings placed flat aligning with body, beak shut, eyes open, tail down - aligning with back angle. Specify the different feather state: normal, very sleek and tight, or fluffed up.
Standing still on floor	The bird is standing still on floor, instead of on perch. There is no head movement for at least 3 seconds.
Resting	The bird is standing upright with one leg tucked into its feathers so that all weight is supported on the other foot. Head is still for at least 3 seconds.

Laying Down	The bird is laying so its legs are tucked under their body, and their abdomen is touching the perch or ground.
Sitting on nest	The bird is sitting on its nest or in its nest - house. (can be multiple spots that are defined as nest either by the zookeepers or by the animal itself by placing nest material in that spot)
Head tucked under wing	Bird has its head tucked under its wing.
Vigilance	The bird is actively looking for a stimulus in the environment, whereby the head is directed towards, and the eyes seem to be fixated on a stimulus, or the head is going from left to right as if to look for something
Abnormal behaviour	
Waving	The bird is waving with its whole body, for no apparent reason.
Head turning	The bird is making erratic movements with its head, in a circle, from left to right or in an 8-figure.
Pacing	The bird is walking or flying repeatedly (at least 3 times) in the same pattern.
Feather pecking	The bird is pulling out or often biting its feathers harder and damaging or ripping them. It can be its own or other birds' feathers.
Nail plucking	The bird is pulling its toenail with its beak.
Maintenance behaviour	
Tail shake*	The tail moves side to side at a quick pace in a shaking motion.
Scratching*	The bird is scratching its face/neck with a foot.
Stretching*	The bird stretches a limb out, typically a leg or wing.
Feaking*	The bird is rubbing its beak on a perch.
Yawning*	Bird is opening its mouth wide.
Rousing/ruffling*	The bird erects its feathers, briefly shakes its whole body, then relaxes its feathers down. It may also flick, or shake, its head back and forth following this behaviour.
Casting pellet / faeces*	Casting of pellet or faeces, specify what.
Preening	The bird is running its beak along and/or lightly biting its feathers.
Bathing	The bird takes a bath in its bath pan, the rain, or other water source. Usually, it fluffs out its feathers and flicks its head. This can also be done in sand. Or the bird is spreading its wings in the sun. Define if it is water, dust- or sun-bathing.
Drying	The bird has its wings stretched out so they are not touching body, the wings can be resting on perch, or held in air, and head is usually tucked in. Often after a bath or rain.
Eating or drinking	The bird is consuming food or water.

Mantling	The bird is hunching or arching shoulders and spreading wings over food to conceal it.
Anticipatory behaviour	
Flapping	The bird is flapping its wings while remaining on its current perch. May be accompanied by: head tilted forward in a low position, legs bent, chest forward almost touching perch, wings open slightly and usually accompanied by head held high. It looks like it wants to go away at any minute.
Premature flying	The bird is regularly flying towards the hatch, the door or to the station, without a trainer asking it to.
Looking out for trainers	This bird is actively looking towards a zookeeper or the direction in which it expects the zookeeper to come from (a zookeeper can be heard or seen).
Social behaviour (specify to which bird)	
Allogrooming	The bird is preening the feathers of another bird.
Aggressive behaviours	The bird is showing aggressive behaviours like fighting (physical contact, with claws or beak).
Threatening behaviours	The bird is trying to displace the other bird by showing raised feathers, legs or wings, is lunging at the other bird or is chasing a bird away from its place by flying to that place.
Seeking close contact	The bird is going towards another bird to seek contact (less than 10 cm between the birds).
Beak against beak	Birds have their beaks together either hitting (hornbills) or like they are feeding each other (macaws)
Copulation	Birds are on top of each other (male on back female)
Stealing food	The bird is stealing or trying to steal food from another bird.
Feeding other	The bird is feeding another bird.
Social vocalization	Birds are making sounds in a low and soft manner, often towards or with each other or towards staff.
Interacting with staff	The bird is interacting with a staff member, to take food, or for training purposes.
Other behaviours	
Flicking with head*	Small flick/twist with head, small head shake.
Stress/alarm vocalizations*	The bird is making loud sounds, screams. Can be used to warn for danger or can be done in distress.
Other behaviours	Any behaviour that doesn't fall within the listed behaviours
Out of sight	Bird is not visible.

Appendix 2

Total number of observation sessions on no-show days (NSD) and on show days (SD), total number of sessions during the different observation periods (P1, P2 and P3) for NSD and SD, the average visible time in minutes per session for NSD and SD and the number of sessions before and after a show. Divided per bird.

	Hans	Batulli	Teku	Wayne	Victory	Kicki	Allen	Tony	Cleo
total # of sessions NSD	30	30	30	30	30	30	30	29	30
total # of sessions SD	30	30	30	30	30	6	30	30	30
# of sessions P1 NSD	15	15	15	15	15	15	15	15	15
# of sessions P2 NSD	15	15	15	15	15	15	14	15	15
# of sessions P2 SD	0	15	15	12	15	6	15	15	15
# of sessions P3 SD	30	15	15	15	15	0	15	15	15
Average visible duration per session (min) NSD	12.6	13.6	14.1	14.6	14.7	14.4	13.5	12.2	13.9
Average visible duration per session (min) SD	15.0	12.4	12.2	14.8	14.6	14.8	14.6	14.1	12.8
Total # of sessions before show	17	15	14	15	11	2	16	15	18
Total # of sessions after show	13	15	16	15	19	4	13	15	12

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