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Evidence-based practice

Using natural history information for zoo animal management: a case study with okapi (*Okapia johnstoni*)

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Abstract
Until recently, the impact that the presence of conspecifics may have on stereotypic behaviour in naturally solitary species exhibited in zoological institutions has largely been ignored. This study examined the effect of adding a visual barrier between animal holding areas at the Brookfield Zoo on stereotypic head-rolling behaviour in an adult female okapi (*Okapia johnstoni*). Instantaneous sampling was used to document the proportion of time the female okapi spent head-rolling prior to and after visual barriers were constructed. Behavioural surveys were also distributed to animal care staff to document behavioural change following the installation of visual barriers. Results from both behavioural observations and animal care surveys suggest that obstructing the view of neighbouring conspecifics significantly reduced head-rolling behaviour and had a positive impact for this okapi. Information gained from this case study will hopefully stimulate discussion around how zoos manage solitary species, and increase research efforts to better understand the effect of the presence of conspecifics on stereotypic behaviour for solitary species. Moreover, we hope these results will contribute to both husbandry recommendations and best practice guidelines for zoo-housed okapi.

Background

A common goal shared by zoos is to improve the welfare and management of the animals under their care. Incorporating characteristics of a species' natural history into management practices is often essential to achieving this goal (Foster and Vincent 2004). Providing animals with species-appropriate social groups and housing is an important first step, and can have a dramatic impact on animal well-being (Morgan and Tromborg 2007; Swaisgood and Schulte 2010). For example, housing naturally solitary felids in small groups in zoos can result in chronic stress (Mellen et al. 1998). Similarly, reducing zoo-housed duiker groups to a more natural population size dramatically reduced stress-related jaw abscesses (Barnes et al. 2002). Studies in primates suggest that natural group compositions can lead to more diverse and natural behaviours (Bloomsmith et al. 1994) and improved reproductive success (Cox 1997; Kuhar et al. 2003; Leong et al. 2004; Maple and Hoff 1982). Additionally, natural group structure with higher levels of affiliative behaviour can reduce stereotypic regurgitation and reingestion (R/R) in bonobos (Miller and Tobey 2012). It therefore appears that a naturalistic social environment is vitally important to several aspects of zoo animal health and welfare.

Stereotypic behaviours such as pacing or R/R can be defined as invariant and repetitive behaviours that seem to have no immediate function (Mason 1991), and are typically considered an indicator of negative welfare (Mason and Veasey 2010). Many authors provide suggestions on how to reduce stereotypic behaviour, with increasing enrichment opportunities as one of the most common strategies (Mason et al. 2007; Shyne 2006; Swaisgood and Shepherdson 2005). While adding enrichment opportunities for animals can indeed reduce the performance of stereotypic behaviour, such solutions treat the symptom (the behaviour) and may fail to address the motivation or cause behind the behaviour itself. Some research has examined possible motivations behind stereotypic behaviour in zoo animals (Miller et al. 2008), but few studies have investigated the motivation behind stereotypic behaviour in okapi, specifically.

Limited data suggest that performance of stereotypic behaviours in okapi may be related to environmental variables, such as exhibit size and complexity, and the length of hay provided during feeding (Fripp et al. 2013; Gilbert and Turner 2003). Social density was found to have an impact on stereotypic behaviour, with small indoor enclosure size and night access to conspecifics predicting oral and pacing behaviour in okapi and giraffe (Bashaw et al. 2001). In the Bashaw et al. (2001) study, okapi represented in the survey were mostly housed in groups, and the incidence of stereotypic behaviour was combined and analysed with giraffe stereotypic behaviour. While the species are related phylogenetically, the social structure of giraffe and okapi differs considerably. Unlike giraffe, which can typically be found in loose, gregarious herds (Estes 1991; van der Jeugd and Prins 2000), okapi are typically solitary in the wild (Bodmer and Rabb 1992; Hart and Hart 1988; Hart 2013). Therefore, considering how okapi are housed in zoos (solitary or in groups; with or without visual access to conspecifics) may play a more important role in understanding the motivation and frequency of stereotypic behaviour in okapi than factors investigated previously. The goal of our case study was to investigate whether blocking visual access to conspecifics by constructing visual barriers could reduce stereotypic head-rolling behaviour in an adult female okapi (*Okapia johnstoni*).

Action

Subject

This study was conducted between June and September 2014 at the Brookfield Zoo, Brookfield IL, USA. The subject of this study was an adult female okapi, born at the Brookfield Zoo in April 2011. An adult male okapi (born in March 1996), and an adolescent male okapi (born in June 2013) were housed in the same barn; however, behavioural observations were only conducted on the female okapi as this was the only individual to perform stereotypic behaviour (as described below). All okapi were housed and fed in individual stalls in the barn, and had no direct physical access to one another throughout the observation period.

Exhibits and holding areas

Animals were on exhibit daily between approximately 0900 and 1600. The female okapi had free access to an indoor and outdoor exhibit yard connected by a holding area. The public had visual access to all three of the female's exhibit areas. While in the holding area, the female okapi could choose to have visual access to both the adult male and adolescent male okapi prior to going on exhibit in the morning, and again after the males were shifted into holding for the evening. The female had no visual access to the males while they were on exhibit, but did have visual access if the males were kept indoors due to inclement weather. A variety of enrichment items, including brushes, browse and pellet feeders, and a variety of salt and seed licks, were available in each animal's exhibit and holding area, and were rotated daily. Enrichment items that were provided to each animal were consistent throughout the study.

Data collection and analysis

Behavioural observations

Eight 30-minute observations were conducted daily for at least three days a week (Monday–Friday) during two time periods: four observations in the morning (0900–1230) and four in the afternoon (1230–1600). Instantaneous sampling of state behaviours was conducted at one-minute intervals (Altmann 1974). A random number generator was used to assign specific observation times and dates. Data were recorded using the Animal Behavior Pro app for iPad (University of Kent; Newton-Fisher 2012). Several behaviours were monitored as part of a larger project, but for the purposes of the present study, only the results for stereotypic head-rolling behaviour will be discussed. Head-rolling was defined as a clockwise circular rotation of the head along a vertical surface (fence line, shift door, etc.), accompanied by alternating stomping of the right front and back left hoof. Inter-observer reliability was achieved using one full day of live observations between two main observers ($r > 0.80$).

Baseline observations were collected from 9 June to 18 July 2014. During the baseline condition, no manipulations to the enclosure were conducted. Visual barriers were then constructed out of plywood and attached to stall walls in the female's holding area using zip ties. The barriers completely blocked the female's view of the males in holding, but did not prevent the female from observing keepers or the public. Behavioural observations with the visual barriers were collected from 21 July to 26 September 2014. A total of 132 hours of data were collected for this study, with approximately 62 hours of baseline data and 70 hours of data with the visual barrier.

Time spent head-rolling was calculated for each day of observation as a proportion of time visible. Proportions were then plotted against sequential observation day, and the celeration line approach was used to examine if a significant change had occurred (Krischef 1991). The celeration line approach has been used extensively in the fields of physical therapy, behavioural therapy and psychiatry to evaluate the efficacy of treatment in single-subject designs (Krischef 1991; Nourbakhsh and Ottenbacher 1994; Wolery and Harris 1982). As our case study also focused on determining effect of treatment on the behaviour of a single subject, we chose to apply this approach to our data to determine treatment effects. Following the procedure outlined in Krischef (1991), the celeration trend line was first constructed from mean data in the baseline phase. Specifically, the baseline period is sectioned into two equal parts based on total number of baseline

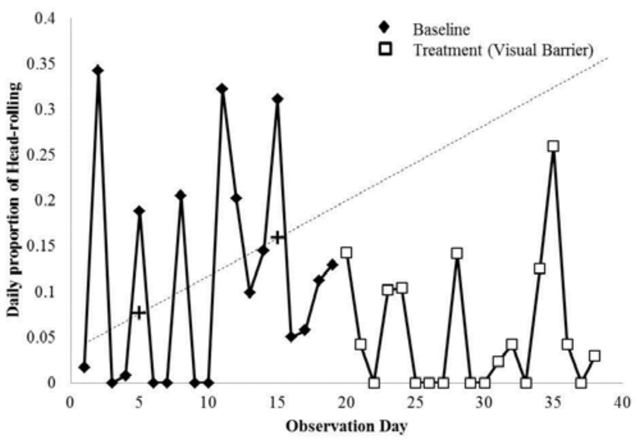

Figure 1. Scatterplot and corresponding celeration line of proportion of time spent head-rolling prior to (baseline) and after implementation of the visual barrier (treatment). Dashed line indicates the celeration line constructed from two mean data points (indicated by **+**) in the baseline phase.

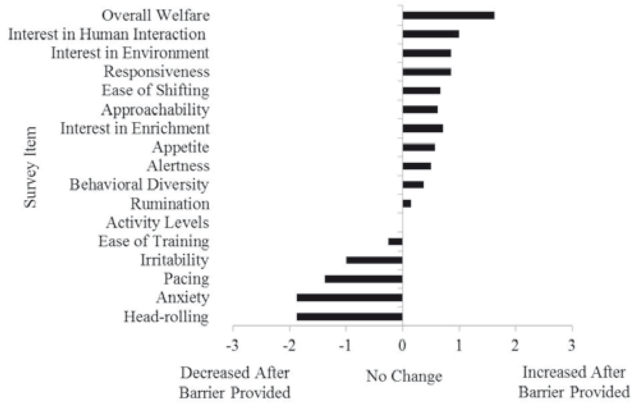

Figure 2. Mean score results from animal care staff surveys (n=8) addressing changes in the female okapi's behaviour after implementation of visual barriers. -3 indicates a large reduction in the survey item (i.e. less/lower) after implementation of the visual barrier, 0 indicates no change, and +3 indicates a large increase in the survey item (i.e. more/higher) after installation of visual barriers.

observations, and a mean is calculated for each portion of the baseline. The celeration line is then created from the two mean baseline values and extended to the treatment phase to evaluate the effect of the treatment. The proportion of data points above and below the line was compared across phases, and a binomial test was used to determine whether the change in the proportion of data points below the celeration line was statistically significant. A significance level of $P < 0.05$ was set to determine effect of treatment.

Survey data

A survey was distributed to all okapi animal care staff (including both full-time and rotational staff; a total of eight individuals) that worked with the female okapi both prior to and following the implementation of the visual barriers. The survey asked staff to rate whether they had observed any changes in the female's behaviour/welfare following the addition of the visual barriers. There were 17 items on the survey (Figure 2), and the survey used a Likert type scale (-3 to +3). A score of -3 indicated a large reduction in the particular behaviour or item (i.e. less/lower) following the construction of the visual barriers, 0 indicated no change and a +3 indicated a large increase in the behaviour or item (i.e. more/higher) after visual barriers. A "Don't know" category was also available. "Don't know" responses were treated as a null response and removed from subsequent data analysis.

Survey results were tallied, and descriptive statistics (mean ± SD) were calculated for each survey item. Intra-class correlations (ICCs) were then performed to determine inter-rater reliability and agreement of survey responses.

Consequences

The average time, based on the proportion of visible scans, in which the female was engaged in head-rolling behaviour in the baseline phase was 9.27±7.33 min, as opposed to 5.88±3.83 min in the treatment phase. Daily proportion of time engaged in head-rolling behaviour is displayed in Figure 1. Once the visual barrier treatment was implemented, all data points during the 19-day treatment phase fell below the celeration line. Binomial test results indicate that implementation of visual barriers significantly decreased the proportion of time the female okapi spent head-rolling ($P < 0.001$).

Eight okapi keepers and curators completed the survey. Of those eight animal care staff, average years of experience with okapi as a species was 10.75 ± 9.81 yrs, and average experience with the female okapi in particular was 2.38 ± 1.51 yrs. Results of the ICC indicated that there was a high level of agreement in survey responses; the average measure ICC was 0.928 with a 95% confidence interval from 0.825 to 0.981 ($F_{(8,56)} = 13.86$, $P < 0.001$). The three highest scoring survey items (indicating greatest increases in item/behaviour after implementation of visual barriers) included overall welfare (1.63 ± 1.60), interest in human interaction (1.00 ± 1.31), and interest in environment (0.86 ± 1.46) (Figure 2). The three lowest scoring survey items (indicating greatest decreases after adding visual barriers) were pacing (-1.38 ± 1.19), anxiety (-1.88 ± 0.99), and head-rolling (-1.88 ± 0.99).

The behavioural results of this study suggest that the female okapi head-rolled significantly less often when her visual access to conspecifics was impeded (5.56% ± 7.19%) compared to baseline (11.53% ± 11.78%). The location of visual barriers did not obstruct the female's view of visitors, nor did it obstruct her view of keepers, lending further support to the notion that blocking visual access to conspecifics was the main variable driving the decrease in her stereotypic behaviour. While it did not exceed the celeration line, a spike in head-rolling did occur during the visual barrier condition. After reviewing keeper records, the temporary increase in head-rolling could have been in response to extensive carpentry activity that occurred near the okapi exhibit on that particular observation day. Even with the disturbance, the visual barriers appear to have a very positive effect on stereotypic behaviour in this female.

The behavioural results coincided with animal care staff perceptions regarding changes in the female okapi's behaviour. Following the implementation of visual barriers, keepers perceived the greatest decreases in all undesirable survey items, namely irritability, pacing, anxiety, and head-rolling. Such responses could indicate that, in addition to improving head-rolling, the visual barriers may have decreased other negative behaviours that were observed by the care staff, but not addressed in the behavioural portion of this study. There was a perceived decrease in ease of training; however, this was due to a single staff member providing a score of -1 whereas all others reported no change (0) or "Don't Know". Animal care staff also perceived changes in several positive behavioural items, with interest in environment, interest in human interaction, and overall welfare all showing the greatest increases after visual barriers. Taken together, these results suggest that animal care staff perceived an overall positive effect of the visual barriers on the female okapi's behaviour.

Wild okapi are typically only found together when mating, or when females are with young (Hart and Hart 1988; Hart 2013). The elusive nature of okapi, combined with the densely forested areas of the Democratic Republic of Congo in which okapi are found (Bodmer and Rabb 1992; Hart and Hart 1988; Hart 2013), may reduce their opportunities to come into visual contact with conspecifics on a frequent basis. Thus, housing okapi in a solitary manner in zoos could provide a social environment similar to that experienced the wild. However, if singly-housed individuals can still see conspecifics in other exhibit areas while direct interaction is prevented, the situation could become frustrating since natural social behaviour cannot be expressed. Over time, such situations could lead to the expression of stereotypic behaviour (Mason et al. 2007). Therefore, providing visual barriers to block access to conspecifics, in addition to housing okapi individually, may more thoroughly represent the social situation experienced by okapi in their native habitat. While our results are based on the responses of a single individual, we nevertheless suggest that visual barriers may be an important management tool to help ameliorate stereotypic behaviour for solitary species, particularly okapi.

In summary, by incorporating natural history information into animal care and management decisions, we were able to positively influence the welfare of an adult female okapi by significantly reducing the proportion of time she spent performing stereotypic head-rolling behaviour. Despite extensive research into the importance of social interactions for zoo-housed gregarious species, little research has investigated the effects of social isolation in solitary species. Multi-institutional studies may be particularly effective in improving our understanding of the influence of conspecifics and social setting on stereotypic behaviours for solitary animals. Such studies can simultaneously facilitate data collection on larger sample sizes and allow for investigation of additional environmental variables that may influence stereotypic behaviours.

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