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Program animal welfare: Using behavioral and physiological measures to assess the well-being of animals used for education programs in zoos

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ABSTRACT

This study investigates program animal welfare using both behavioral and physiological measures in two separate experiments. In Experiment One, we examined possible differences in behavior and fecal glucocorticoid metabolites (FGM) between education, exhibit and off-exhibit armadillos ($N = 59$) housed at 17 Association of Zoos and Aquariums (AZA) accredited zoos. In Experiment Two, the specific effect of handling for education programs was investigated in an ABA study design using the same measures of welfare in armadillos ($N = 10$), hedgehogs ($N = 12$), and red-tailed hawks ($N = 6$) at 11 AZA institutions. Mixed model analysis revealed FGM and undesirable behaviors did not differ between groups in Experiment One (FGM [μg/g feces]: Median[Interquartile Range] education: 28.49[21.05-42.29], exhibit: 30.38[26.33–42.56], off-exhibit: 28.2[23.92–47]; F2, 46 = 0.55, $p = 0.58$; undesirable behavior: Least Squares Mean% of time [SEM]: education: 24.95[14.52], exhibit: 9.09[4.16]; F1, 17 = 1.86, $p = 0.19$). There was also no effect of handling specifically for education programs on measures of welfare in Experiment Two ($p > 0.05$ in all FGM and undesirable behavior models). However, the overall amount of handling that an animal experienced (for programs or for husbandry) was positively correlated with FGM in Experiment One (F1, 979 = 9.35, $p = 0.002$) and in all species in Experiment Two (armadillos: F1, 286 = 5.69, $p = 0.02$; hedgehogs: F1, 448 = 4.92, $p = 0.03$; hawks: F1, 215 = 4.68, $p = 0.03$). Amount of handling was also associated with several behaviors (undesirable, rest, and self-directed behavior) in both experiments ($p < 0.05$ in all models), indicating that management purpose is not the primary contributor to welfare in these species. In addition, the depth of substrate provided and enclosure size were also negatively correlated to FGM and consistently related to behavior in both Experiments ($p < 0.05$ in all models), highlighting the importance of housing environment for animal welfare. Our findings will serve as a basis for developing handling recommendations for zoo-housed armadillos, hedgehogs, and red-tailed hawks, and for planning future research investigating the needs and welfare of education program animals.

1. Introduction

In the past several decades, zoos and aquariums have shifted from sources of entertainment to centers for conservation education (Andersen, 2003; Reade and Waran, 1996). Although zoos employ a variety of educational techniques to convey messages, one of the most popular is the use of live animals in interpretive programs (Andersen, 2003). The Association of Zoos and Aquariums (AZA) recognizes program animals as "an important and powerful educational tool that provides a variety of benefits to zoo and aquarium educators" (AZA Program Animal Position Statement, 2003). Indeed, several studies have demonstrated that using live animals not only increases knowledge retention, but can be effective in changing visitor attitudes about wildlife, conservation, and personal responsibility to the environment (Morgan and Gramann, 1989; Povey, 2002; Swanagan, 2000; Yerke and Burns, 1991). Povey and Rios (2002) measured zoo visitor interest and empathy toward a single clouded leopard when participating in an interpretive program and while on exhibit. The live demonstration resulted

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in longer viewing times, more information seeking behavior, and more positive feelings about the animal's quality of life. Although this may be the perception of the average zoo visitor, debate continues regarding the ethical and welfare implications of using live animals in education programs (Ballantyne et al., 2007; Shani and Pizam, 2008).

There has been some investigation into the effects of zoo visitors on exhibited animals. Hosey (2000) defined three types of effects that visitors may have on zoo animals: a source of stress, a source of enrichment, or a relatively neutral effect. Though some studies have suggested that visitors might have an enriching effect (Miller et al., 2011; Nimon and Dalziel, 1992), other studies show the opposite—that zoo visitors are a source of stress (reviewed in Davey, 2007; Fernandez et al., 2009 and Hosey, 2000). It is also important to note that group (Kuhar, 2008) and individual differences (Sellinger and Ha, 2005; Stoinski et al., 2012) in behavioral responses to visitor presence have been reported, suggesting there may not be a single, generalized "visitor effect".

Most visitor effect studies have been restricted to animals (often primates) housed on exhibit and the effects of onlookers. Unlike exhibit animals, education program animals are frequently handled, transported, and come into close contact with humans. Thus, education animals could have a different response to human interaction than most exhibit animals. Several studies have demonstrated that frequent positive human interactions, including repeated handling, are associated with a reduction in the fear response of various species in their subsequent encounters with humans (sheep: Hargreaves and Hutson, 1990; pigs: Hemsworth et al., 1986b; rabbits: Podberscek et. al., 1991). However, these studies focused on domestic animals and similar efforts in wild species have yielded mixed results (wombats: Hogan et al., 2011; koalas: Narayan et al., 2013). Further, there has been little investigation into the specific effects – positive or negative – of education program use on animal welfare.

The purpose of this study was to empirically evaluate program animal welfare using established physiological [fecal glucocorticoid metabolite (FGM)] and behavioral measures of welfare. The use of multiple measures of welfare is generally preferred, as different measurement techniques can give conflicting results if considered independently (Broom and Johnson, 1993; Hill and Broom, 2009; Wielebnowski, 2003). Because there has been little research on this topic, we wanted to evaluate potential effects of education program animal use in broad terms with the intention of guiding future, specific studies. Therefore, the aim of Experiment one was to determine if there are any physiological and behavioral differences between animals managed for either education or exhibit. Armadillos were chosen for Experiment one due to their common presence both in education programs and as exhibit animals in multiple institutions. For Experiment one, we hypothesized that behavioral and physiological measures of welfare would differ between education and exhibit animals. Specifically, we predicted that education animals would have higher FGM levels and demonstrate increased undesirable behavior compared to exhibit armadillos. Because handling is a central component of program animal use, the aim of Experiment two was to examine the specific effect of handling on measures of welfare in animals used for education programs. Because we wanted to evaluate the effect of handling on the variety of taxa frequently utilized in education programs, we chose to include hedgehogs and red-tailed hawks in addition to armadillos in Experiment two. In this Experiment, we hypothesized that handling during programs would have no effect on the welfare of education animals, with behavior and FGM concentrations of education animals being similar during periods of regular program use and periods vs. no program use.

2. Methods

2.1. Experimental design

All methods and animal use were reviewed and approved by each participating institution and the Animal Care and Use Committee at Cleveland Metroparks Zoo.

2.1.1. Experiment one

To compare physiological and behavioral measures of welfare, La Plata, or Southern three-banded, (*Tolypeutes matcus*; $n = 51$), screaming (*Chaetophractus vellerosus*; $n = 5$), nine-banded (*Dasypus novemcinctus*; $n = 2$), and six-banded (*Euphractus sexcinctus*; $n = 1$) armadillos housed at 17 AZA accredited institutions were sampled for 60 days between April and September 2012. Individuals were classified as education, exhibit, or off-exhibit based on where the animal was housed and whether it participated in live animal education programs. Education animals were used in at least one educational program during the study. Animals that were not used for education programs, but housed on exhibit for public viewing were classified as exhibit. Armadillos that were neither used for education programs nor housed on exhibit were classified as off-exhibit; typically maintained in holding areas for breeding purposes with no exposure to the public.

Fecal samples were collected approximately every other day from 57 armadillos (28 education, 17 exhibit, 12 off-exhibit; see Section 2.3). Institutions that were able to commit time and resources also collected behavioral data from a subset of armadillos (7 education, 13 exhibit, 3 off-exhibit; see Section 2.5). A minimum of ten morning (0700–1000) and ten afternoon (1500–1800) observations were collected for each animal. For two La Plata armadillos (1 education, 1 exhibit) from the same institution, behavioral data, but not fecal samples, were collected.

2.1.2. Experiment two

To determine the specific effect of handling on education program animals, La Plata armadillos ($n = 9$), a screaming armadillo ($n = 1$), African hedgehogs (*Atelerix albiventris*; $n = 12$), and red-tailed hawks (*Buteo jamaicensis*, $n = 6$) at 11 AZA institutions were sampled for 9 weeks between December 2011 and July 2012. All subjects were "education animals", defined as being used in live animal demonstrations with the public at least two times during the study. The study period was divided into three, 3-week "phases", with each animal used as its own control. In the "Baseline" phase, animals were handled as usual for education programs. In the subsequent "No Handle" phase, animals were not used in any programs or demonstrations. However, for some animals, handling for routine husbandry (picked up for cage cleaning, weighing, etc.) continued throughout this period. During the final "Post" phase, animals were returned to normal education program use. Fecal samples were collected approximately every other day from all subjects (see Section 2.3). Behavioral data were also collected from 7 armadillos and 6 hawks (see Section 2.5). A minimum of five morning (0700–1000) and five afternoon (1500–1800) observations were conducted during each phase of the study.

2.2. Demographic, husbandry, and handling data collection

We chose to examine the potential influence of direct and controllable environmental and husbandry variables in this first investigation, detailed in Table 1 (Experiment one) and Table 2 (Experiment two). Demographic and husbandry data included sex and age (if known), enclosure size, type and average depth of substrate provided, and whether the animal was housed under a reversed light cycle (dark during daytime hours). Institutions reported whether the animal is handled regularly, if the animal was