

Development of an Evidence-Based Welfare Approach for Cheetahs (*Acinonyx jubatus*) in Human Care

B. Fischer, M. Flint, K. Cole, and K.A. George

INTRODUCTION

Animal welfare underpins the transformation of animal management in many contexts, including zoos (1). In 2017, the Association of Zoos and Aquariums (AZA) established a new accreditation standard requiring all member institutions to have a formal animal welfare process (2). As a result, the Animal Programs Department at the Columbus Zoo and Aquarium sought partnership with the Center for Human-Animal Interactions Research & Education (CHAIRE) to develop an animal welfare assessment for their department using a focal species, the cheetah (*Acinonyx jubatus*). A multi-faceted approach was developed using the Five Domains Model as a framework for one year, divided into six 60d periods, to measure welfare (3). Environmental factors examined to determine effect on welfare included participation in a cheetah run activity, HOA region of the zoo being open vs. closed to the public, and housing. Behavioral and health data were also examined. This study provided a foundation for welfare assessments of cheetahs as well as other species within human care in the future.

OBJECTIVE

Development of a multi-faceted non-invasive approach to measure animal welfare.

HYPOTHESES

- Cortisol production will be positively correlated with stereotypic behavior.
- Participation in cheetah run will be negatively correlated with stereotypic behavior and cortisol levels.
- Open HOA region will have a negative correlation with cortisol levels and stereotypic behavior.
- Housing will have no effect on behavior and cortisol.

Table 1. Cheetah Individual Histories

Cheetah	Location	Sex	Age	Run	Housing
1*	1	M	8	N	P
2	1	F	8	Y	P
3	2	F	5-6yrs	Y	P
4	2	F	5-6yrs	N	P
5	3 & 10	M	3-4yrs	N	S
6	4	F	4	Y	P
7	4	M	4	N	P
8	5	M	2-3yrs	Y	S
9	6	F	1-2yrs	Y	T
10	6	F	1-2yrs	Y	T
11	6	F	1-2yrs	Y	T

Age range indicates that animal had a birthday during study
*Indicates intact male

MATERIALS & METHODS

- Hair samples collected every 60d with electric trimmers.
- Behavior recorded using scan sampling for a total of six observations per period.
- Individual histories acquired using CZA data base, medical records, and interviews with staff.
- Correlation of stereotypic behavior and cortisol were tested using repeated measures within linear mixed effects model.

Figure 1. Data Collection Methods



Table 2. Data Collection Timeline

Period	HOA Region	Cheetah Run
1(Oct-Nov)	open	yes
2(Dec-Jan)	closed	no
3(Feb-Mar)	closed	no
4(Apr-May)	mixed	no
5(Jun-Jul)	open	yes
6(Aug-Sept)	open	yes

Table 3. Odds Ratios Estimates for Stereotypic Behavior of Population

Covariate	Reference Covariate	Estimate	95% Confidence Interval	P Value
Run(N)	Run(Y)	0.62	(0.44-0.89)	0.01
Housing(P)	Housing(T)	3.8	(1.41-10.24)	0.01
Housing(S)	Housing(T)	4.64	(1.40-15.34)	0.01
Period(1)	Period(6)	3.68	(2.60-5.21)	<0.01
Period(2)	Period(6)	6.34	(2.09-19.20)	<0.01
Period(3)	Period(6)	5.86	(1.93-17.78)	<0.01
Period(4)	Period(6)	Non-est	-	-
Period(5)	Period(6)	1.14	(0.78-1.67)	0.5

Estimates <1 indicate decreased likelihood of behavior within covariate one category
Estimates >1 indicate increased likelihood of behavior within covariate one category

RESULTS

Group Type III Test:

- The cheetah run activity ($P<0.01$), housing ($P=0.01$), and period ($P<0.01$) were found to influence behavior (Table 3).
- HOA region ($P=0.77$), housing ($P=0.50$), cheetah run ($P=0.64$), and period ($P=0.36$) had no effect on cortisol.

Individuals Type III Test:

- Cheetah ($P<0.01$), interaction of cheetah and HOA ($P=0.04$), and interaction of cheetah and run ($P=0.02$) effected stereotypic behavior.
- Cheetah ($P=0.01$) and trend of interaction of cheetah and run ($P=0.05$) effected cortisol levels. No effect of interaction of cheetah and HOA ($P=0.17$) (Table 4).

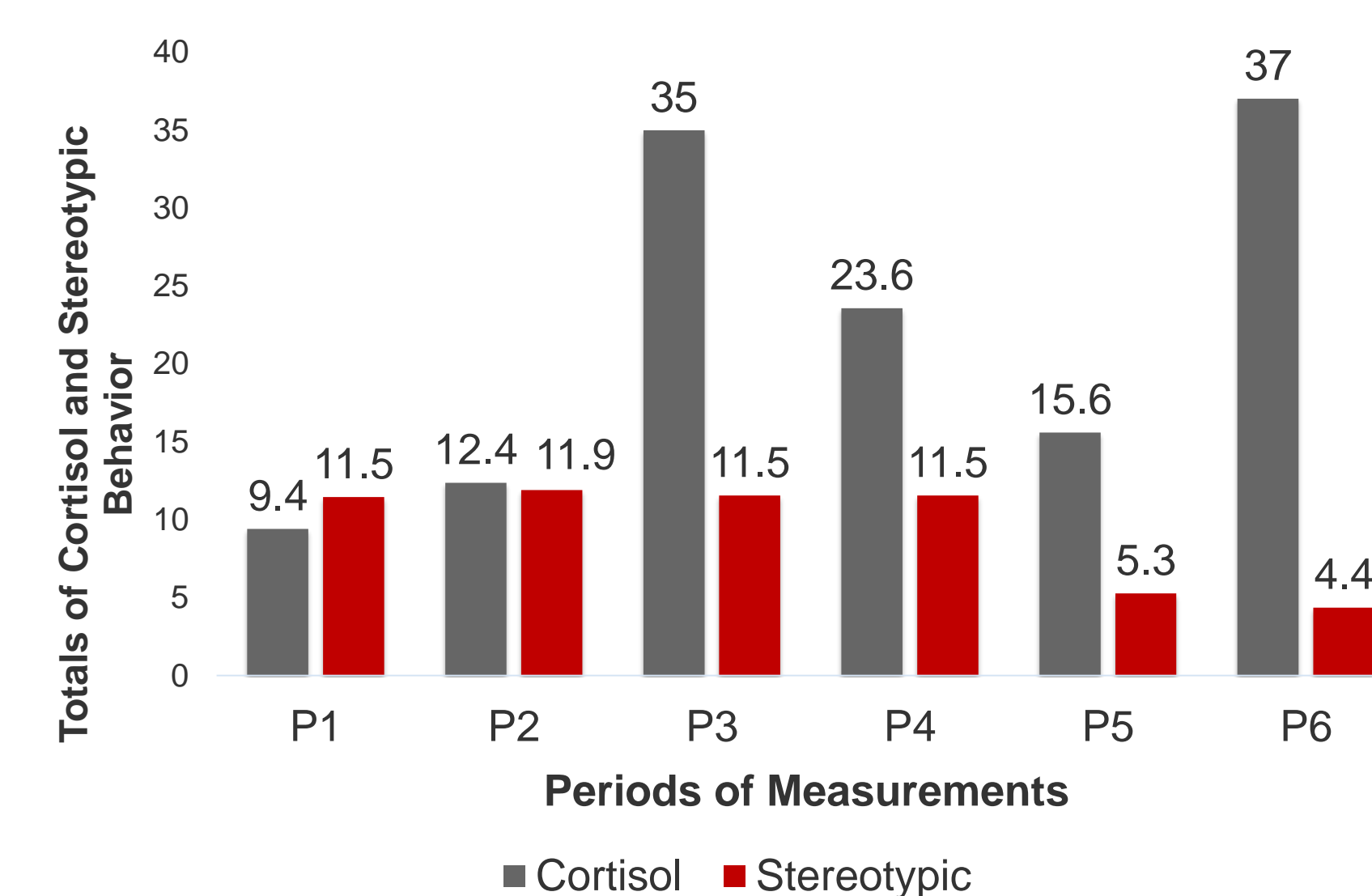
Correlation Type III Test:

No correlation of stereotypic behavior and cortisol was found ($P=0.12$) (Figure 2).

Table 4. Least Square Means Estimated Parameters & P Values of Cortisol of Individuals

	Cheetah	Cheetah	Cheetah*Run
1	Individual	54.16(<0.01)	
	Yes		
7	Individual	70.41(<.001)	
	Yes		
10	Individual	44.74(0.01)	
	Yes		36.19(0.12)
	No		54.16(<0.01)
	No		53.29(0.03)

Figure 2. Group Averages Over Six Periods



DISCUSSION & CONCLUSIONS

- To our knowledge this study was the first to use hair sampling to measure cortisol production in cheetahs (5).
- Rejection of our first hypotheses indicated the presence of anticipatory behavior of rewarding activities such as the cheetah run activity (6).
- Negative correlation of cheetah run and cortisol within three cheetahs led to recommendations to provide opportunities for positive welfare during those periods (3).
- No effect of HOA indicated cheetahs' ability to adapt to changes in environment and absence of influence of public.
- Cheetahs housed as a triple found to have decreased stereotypic behavior but no effect of cortisol leading to rejection of a portion of our fourth hypothesis.
- Analysis of population allowed for comparison to other cheetahs within human care and individual analysis to determine how cheetahs were coping differently within their changing environments.

REFERENCES

- (1) Whitham, J.C., Wielebnowski, N. 2013. New Directions for Zoo Animal Welfare Science. *Applied Animal Behaviour Science, Welfare of Zoo Animals*, 147(3), 247-60.
- (2) Association of Zoos and Aquariums (AZA). 2020. The Accreditation Standards & Related Policies: 2020 Edition.
- (3) Mellor, D.J., Beausoleil, N.J. 2015. Extending the 'Five Domains' Model for Animal Welfare Assessment to Incorporate Positive Welfare States. *Animal Welfare* 24, 241-253.
- (4) Isaac, A., Ibrahim, Y., Andrew, A., Edward, D., Solomon, A. 2017. The Cortisol Steroid Levels as a Determinant of Health Status in Animals. *Journal of Proteomics and Bioinformatics* 10, 277-283.
- (5) Wielebnowski, N.C., Ziegler, K., Wildt, D.E., Lukas, J., Brown, J.L. 2002a. Impact of Social Management on Reproductive, Adrenal, and Behavioural Activity in the Cheetah (*Acinonyx jubatus*). *Animal Conservation* 5(4), 291-301.
- (6) Watters, J.V. 2014. Searching for Behavioral Indicators of Welfare in Zoos: Uncovering Anticipatory Behavior. *Zoo Biology* 33(4), 251-56.

ACKNOWLEDGEMENTS

We would like to thank the Columbus Zoo and Aquarium's Animal Programs Department for their participation in this project.