

**Program of the
Thirty-Eighth
Meeting of
The American Society of Primatologists**

Karen L. Bales and Katie Hinde

-Guest Editors-

**Bend, OR
June 18-21, 2015**

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The Program Committee expresses their great appreciation for Nancy Capitanio and her continuing contributions to the development of the on-line abstract submission and program preparation for the ASP. The Program Committee particularly acknowledges Grace H. Lee, Jessica Vandeleest, and Christopher Schmidt for their contributions to the editing process for the preparation of this special issue.

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Scientific Sessions, Social Gatherings and Special Events

The scientific and social portions of the meeting was held at the
The Riverhouse Hotel and Convention Center

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The ASP recognizes the 2015 and 2014 Award Winners

2015 Distinguished Primatologist Award Recipient

Frans B. M. de Waal
Emory University, Department of Psychology
Atlanta, GA

2014 Distinguished Primatologist Award Recipient

Chuck Snowdon
University of Wisconsin, Department of Psychology
Madison, WI

2015 and 2014 Student Competition Winners

Outstanding Oral Paper:

2015

Jonathan Clayton

Associations between diet, gut microbial communities, and health in red-shanked doucs
(*Pygathrix nemaeus*)

2014

Marnie Silverstein

Effects of Selective Serotonin Reuptake Inhibitors and Social Stress on Body Composition
and Carbohydrate Metabolism in Female Cynomologous Macaques (*Macaca
fascicularis*)

Honorable Mention Oral Paper:

2015

Stephanie Fox

Affiliation, tolerance, and proximity between males and infants in wild *Colobus vellerosus* in
Ghana is not explained by genetic sireship"

Outstanding Poster:

2014

Jessica Rachelle Wombolt

Common Marmosets' (*Callithrix jacchus*) Responses to Snake Characteristics

Honorable Mention Poster:

2015

Lauren Wooddell

"Elo-Rating as a tool to measure rank changes and dominance stability in semi-free ranging Rhesus macaques (*Macaca mulatta*)"

2015 Legacy Award Recipient

Amanda Dettmer

Laboratory of Comparative Ethology

Eunice Kennedy Shriver National Institute for Child Health and Human Development
Bethesda, MD

2014 Early Career Achievement Award Recipient

Katie Hinde

Department of Human Evolutionary Biology, Harvard University, Cambridge, MA

2015 Senior Research Award Winner

Susan Lambeth

Keeling Center for Comparative Medicine and Research at the University of Texas MD
Anderson Cancer Center, Bastrop, TX

2014 President's Award Recipient

Dr. Randall Kyes

Washington National Primate Research
Center

Dr. Melinda Novak

University of Massachusetts, Amherst

The 38th Meeting
of the
American
Society
of
Primatologists

Scientific Program

2014 ASP Meeting Scientific and Social Program

Wednesday, June 17, 2015 : Day 1

07:30 AM-09:00 PM	REGISTRATION DESK (Hall/Lobby)
09:00 AM-12:00 PM	ASP EDUCATION COMMITTEE PRE-CONFERENCE EDUCATIONAL OUTREACH: Amanda M. Dettmer and M. Karen Hambright (Cascade E) [3]
09:00 AM-12:00 PM	WORKSHOP ON PRIMATE SOCIAL NETWORKS (COCC Science Center) [2]
01:00 PM-03:00 PM	PROGRAM COMMITTEE (Cascade E)
01:00 PM-03:00 PM	CONSERVATION COMMITTEE (Cascade F)
01:00 PM-03:00 PM	EDUCATION COMMITTEE (Cascade H)
01:00 PM-03:00 PM	PUBLICATIONS COMMITTEE (Cascade I)
01:00 PM-03:00 PM	MEMBERSHIP AND FINANCE COMMITTEE (Sisters B)
03:00 PM-05:00 PM	PRIMATE CARE COMMITTEE (Cascade E)
03:00 PM-05:00 PM	RESEARCH AND DEVELOPMENT COMMITTEE (Cascade F)
03:00 PM-05:00 PM	AWARDS COMMITTEE (Cascade H)
03:00 PM-05:00 PM	STUDENT COMMITTEE (Cascade I)
03:00 PM-05:00 PM	MEDIA AND INFORMATION COMMITTEE (Sisters B)
05:00 PM-06:30 PM	Past President's Reception (TBD)
06:30 PM-08:30 PM	OPENING RECEPTION (Cascade AJBCD)

Thursday, June 18, 2015 : Day 2

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08:15 AM-09:00 AM	OPENING REMARKS AND DATA BLITZ (Cascade AJBCD) [18]
09:00 AM-10:15 AM	MONKEYS IN SPACE: GEOGRAPHY, ECOLOGY AND SOCIAL LIFE (Cascade AJBCD) [19]
10:15 AM-10:30 AM	BREAK

10:30 AM-11:30 AM	PRESIDENT'S FORUM: LABORATORY RESEARCH WITH NONHUMAN PRIMATES: CONCEPTUAL, ETHICAL, AND REGULATORY ISSUES. (Cascade AJBCD)
11:30 AM-12:30 PM	LUNCH ON YOUR OWN
12:30 PM-02:50 PM	INTERDISCIPLINARY SYMPOSIUM ON PRIMATE SOCIAL AND BIOLOGICAL NETWORKS (Cascade AJBCD) [24]
12:30 PM	NETWORK DYNAMICS OF SOCIAL STABILITY B. A. Beisner, H. Fushing, B. McCowan[25]
12:50 PM	QUANTIFYING INFORMATION TRANSFER ACROSS SOCIAL NETWORKS: TOOLS, APPLICATIONS AND ECOLOGICAL IMPLICATIONS D. R. Farine, W. Hoppitt[26]
01:10 PM	COLLECTIVE MOVEMENT IN SOCIALLY AND ENVIRONMENTALLY HETEROGENEOUS SYSTEMS: A CASE STUDY IN OLIVE BABOONS M. C. Crofoot, D. R. Farine, A. Strandburg-Peshkin, I. Brugere, J. Li, T. Y. Berger-Wolf[27]
01:30 PM	A SOCIAL NETWORK PERSPECTIVE ON MACAQUE SOCIAL STYLES. J. Duboscq, V. Romano, A. MacIntosh, C. Sueur[28]
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02:10 PM	ESTABLISHING THE RELIABILITY OF RHESUS MACAQUE SOCIAL NETWORK ASSESSMENT FROM VIDEO OBSERVATIONS E. Feczko, T. A. Mitchell, H. Walum, J. M. Brooks, T. R. Heitz, L. J. Young, L. A. Parr[31]
02:30 PM	MORE THAN JUST A NUMBERS GAME: POPULATIONS, NETWORKS, AND DISEASE DYNAMICS IN PRIMATES C. M. McCabe, F. Jordán, C. L. Nunn[32]
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03:00 PM-05:10 PM	EVOLUTIONARY PERSPECTIVES ON BEHAVIOR, BONES, AND DEVELOPMENT (Cascade H) [34]

03:05 PM	<p>TESTING THE VARIABILITY SELECTION HYPOTHESIS IN MACAQUES. A. R. Eller, K. G. Morley, H. A. Sullivan III, F. J. White[38]</p>
03:20 PM	<p>COMMUNITIES OR CLIQUES? A REEXAMINATION OF BONOBO SOCIAL ORGANIZATION M. T. Waller, M. L. Wakefield, K. J. Boose, F. J. White[41]</p>
03:35 PM	<p>A REASSESSMENT OF THE PHYLOGEOGRAPHY OF THE SULAWESI MACAQUES BASED ON 3D GEOMETRIC MORPHOMETRICS M. Anderson, S. R. Frost[44]</p>
03:50 PM	<p>COMPARISON OF MEASURES OF INTER-INDIVIDUAL AFFILIATION AMONG RING-TAILED LEMURS (<i>LEMUR CATT</i>A) L. E. Gotuaco, C. M. Brand, C. G. Oliveira, K. Ortiz, T. K. Lucas, F. J. White [47]</p>
04:00 PM	<p>BREAK [Add To Schedule]</p>
04:10 PM	<p>BERGMANN'S RULE IN SKULL SIZE AND CLINAL VARIATION IN SKULL SHAPE OF WILD VS. CAPTIVE <i>FASCICULARIS</i> GROUP MACAQUES J. L. Arenson, M. Anderson, A. Eller, E. Simons, F. J. White, S. R. Frost [52]</p>
04:25 PM	<p>LATERALITY OF GROOMING AND TOOL USE IN A GROUP OF CAPTIVE BONOBO (<i>PAN PANISCUS</i>) C. M. Brand, L. F. Marchant, K. J. Boose, F. J. White, T. M. Rood, A. Meinelt [55]</p>
04:40 PM	<p>MORPHOLOGICAL SIGNALS AND MATING SYSTEMS: COMPARING MEASURES OF CRANIAL FLUCTUATING ASYMMETRY AND SECOND-TO-FOURTH DIGIT RATIO IN PRIMATES. K. S. Clarke, K. P. McNulty, A. R. Eller, J. L. Arenson, M. Anderson, E. Simons, F. J. White, S. R. Frost [58]</p>
04:55 PM	<p>MIND OVER MATTER: AN ONTOGENETIC PERSPECTIVE M. N. Muchlinski, H. Vollrath, H. Hemingway [61]</p>

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03:00 PM	<p>HAIR CORTISOL IS ASSOCIATED WITH CHANGES IN HAIR LOSS AND BODY CONDITION ACROSS PUBERTY IN MALE RHESUS MONKEYS A. M. Dettmer, R. A. Woodward, K. Rosenberg, S. J. Suomi, M. A. Novak, J. S. Meyer [37]</p>
03:15 PM	<p>RANK AND DOMINANCE UNCERTAINTY INFLUENCE PRO-INFLAMMATORY CYTOKINE AND VIRAL ANTIBODY LEVELS IN RHESUS MACAQUES (<i>MACACA MULATTA</i>) J. J. Vandeleest, B. A. Beisner, D. L. Hannibal, J. P. Capitanio, B. McCowan [40]</p>
03:30 PM	<p>OXYTOCIN AND SOCIAL BUFFERING IN MARMOSETS J. Cavanaugh, C. M. Rose, J. A. French [43]</p>
03:45 PM	<p>OXYTOCIN, TESTOSTERONE, AND THE INITIATION OF AGGRESSION IN BONOBO (<i>PAN PANISCUS</i>) K. Boose, E. Midttveit, F. White, A. Meinelt, J. Snodgrass [46]</p>
04:00 PM	<p>PROLACTIN AND OXYTOCIN: INTERACTIONS AND DUAL ROLES T. E. Ziegler, C. T. Snowdon [50]</p>
04:15 PM	<p>EARLY REARING EXPERIENCE MODULATES TEMPERAMENT AND ACTIVITY OF THE OXYTOCIN SYSTEM AND HYPOTHALAMIC-PITUITARY-ADRENOCORTICAL (HPA) AXIS IN INFANT RHESUS MONKEYS (<i>MACACA MULATTA</i>) A. F. Hamel, A. M. Dettmer, M. M. Miller, S. J. Suomi, J. S. Meyer, M. A. Novak [53]</p>
04:30 PM	<p>GENETIC REGULATION OF HIPPOCAMPAL SIZE TRAIT IN VERVET MONKEYS A. J. Jasinska, S. Service, S. Fears, I. Zelaya, Y. Huang, L. Navarro, M. Jorgensen, G. Weinstock, W. Warren, R. Woods, G. Coppola, N. Freimer [56]</p>
04:45 PM	<p>CAPTIVE BONOBO URINARY CORTISOL FOLLOWS DIURNAL RHYTHM: IMPLICATIONS FOR PRIMATE SOCIO-ENDOCRINOLOGY RESEARCH E. C. Squires, K. J. Boose, F. J. White, A. Meinelt, J. J. Snodgrass [59]</p>

05:00 PM	<p>VARIATION IN MALE AGGRESSIVENESS BETWEEN WILD CHACMA BABOONS IN BOTSWANA AND GUINEA BABOONS IN SENEGAL AND THEIR RELATION TO FT AND FGC PATTERNS U. Kalbitzer, M. Heistermann, D. Cheney, R. Seyfarth, J. Fischer [62]</p>
03:00 PM-05:20 PM	<p>THE ADVANCEMENT OF THE MODERN PRIMATE SANCTUARY AND THE GROWTH OF COLLABORATIVE OPPORTUNITIES (Cascade F) [35]</p>
03:05 PM	<p>THE EVOLUTION OF PRIMATE SANCTUARIES IN THE UNITED STATES E. W. Fleury[39]</p>
03:20 PM	<p>RESEARCH RETIREMENT: BRIDGING THE GAP BETWEEN RESEARCH AND SANCTUARY K. Bagnall [42]</p>
03:35 PM	<p>WHAT ENABLES A UNIVERSITY TO WORK EFFECTIVELY WITH A PRIVATE SANCTUARY TO RETIRE NONHUMAN PRIMATES D. M. Fragaszy, C. King, L. Alworth [45]</p>
03:50 PM	<p>CHALLENGES ASSOCIATED WITH INITIATING A NEW SANCTUARY FOR OLD WORLD PRIMATES S. D. Kubisch [48]</p>
04:05 PM	<p>PROMOTING A SUCCESSFUL TRANSPORTATION AND RELOCATION PROCESS FOR CAPTIVE CHIMPANZEES (<i>PANTROGLODYTES</i>) S. P. Lambeth, S. J. Schapiro [51]</p>
04:20 PM	<p>THE RETIREMENT AND INTEGRATION OF FORMER LABORATORY-HOUSED CHIMPANZEES (<i>PANTROGLODYTES</i>) AT CHIMP HAVEN A. Fultz, K. Taylor , R. Jackson-Jewett[54]</p>
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04:50 PM	<p>OPPORTUNITIES AND CHALLENGES IN REALIZING THE RESEARCH POTENTIAL OF SANCTUARIES S. R. Ross [60]</p>

<p>05:05 PM</p>	<p>VETERINARY CARE OF CHIMPANZEES (<i>PAN TROGLODYTES</i>) AT THE SAVE THE CHIMPS SANCTUARY J. Bezner[63]</p>
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	LABORATORY HOUSED RHESUS MACAQUES (<i>MACACA MULATTA</i>) WITH SELF INJURIOUS BEHAVIOR SHOW A BLUNTED BEHAVIORAL RESPONSE TO THE HUMAN INTRUDER TEST E. J. Peterson, J. M. Worlein, G. H. Lee, A. M. Dettmer, E. K. Varner, M. A. Novak[92]
07:00 PM-09:00 PM	EXECUTIVE COMMITTEE MEETING (Boardroom)
Friday, June 19, 2015 : Day 3	
07:30 AM-07:00 PM	REGISTRATION DESK (Hall/Lobby)
08:15 AM-08:30 AM	OPENING REMARKS (Cascade AJBCD)
08:30 AM-09:30 AM	THE LEGACY OF PLACENTAL FUNCTION IN PRIMATE BRAIN DEVELOPMENT AND EVOLUTION (Cascade AJBCD) [110]
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11:15 AM	A COMPARISON OF PROXIMITY VALUES BETWEEN CHIMPANZEES (<i>PAN TROGLODYTES</i>) IN A STABLE AND UNSTABLE GROUP L. Case, A. Fultz, L. Cohen, E. Loeser[133]
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10:15 AM	SQUIRREL MONKEYS DEMONSTRATE THE IDENTITY CONCEPT ON A MATCH-TO-SAMPLE TASK P. G. Judge, O. Tomeo, S. L. Zander, B. Powell, L. E. Miller[122]
10:30 AM	HOW ECOLOGICAL VALIDITY INFLUENCES THE PERFORMANCE OF FISH (<i>LABROIDESDIMIDIATUS</i>) AND PRIMATES (<i>CEBUS APELLA</i>) IN A FORAGING TASK L. Pretot, R. Bshary, S. F. Brosnan[125]
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03:00 PM-04:45 PM	CONTRIBUTED TALKS: CONSERVATION. Chair: Marilyn Norconk (Cascade F)

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03:45 PM	<p>DEMOGRAPHIC AND EPIDEMIOLOGICAL ANALYSIS OF CAPTIVE CHIMPANZEES (<i>PAN TROGLODYTES</i>) FORMERLY USED IN BIOMEDICAL OR BEHAVIORAL RESEARCH J. Ely, L. Williams, J. Cohen, F. C. Connor-Stroud, P. Sharma, C. Abee[154]</p>
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03:15 PM	<p>AN ANALYSIS OF SELF-INJURIOUS BEHAVIOR IN A LARGE SAMPLE OF CAPTIVE PRIMATES M. Bloomsmith, K. Baker, R. Bellanca, K. Coleman, M. Fahey, C. Lutz, A. Martin, B. McCowan, J. Perlman, J. Worlein[147]</p>

03:30 PM	<p>MINIMIZING THE LIFETIME SEVERITY OF SELF-INJURIOUS BEHAVIOR IN AFFECTED RHESUS MACAQUES (<i>MACACA MULATTA</i>) K. C. Baker[150]</p>
03:45 PM	<p>EXTREME BEHAVIORAL PHENOTYPES, HYPOTHALAMIC-PITUITARY ADRENAL AXIS (HPA) ACTIVITY AND ANXIETY IN RHESUS MACAQUES (<i>MACACA MULATTA</i>) M. Novak, E. J. Peterson, K. Rosenberg, E. K. Varner, J. M. Worlein, G. H. Lee, R. U. Bellanca, J. S. Meyer[153]</p>
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Abstracts
of the
Thirty-Eighth
Annual Meeting
of the
American Society of Primatologists
Bend, OR
June 18-21, 2015

CONTRIBUTED ABSTRACTS

2. WORKSHOP ON PRIMATE SOCIAL NETWORKS

B. McCowan^{1,2}, B. Beisner^{1,2}, J. Jin^{1,2}, J. Vandeleest^{1,2}, K. Fuji³, S. Chan³, H. Wang³, A. Shev³ and F. Hsieh³

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The McCowan Animal Behavior Laboratory in collaboration with the Statistics Department at UC Davis is offering a 3-hour workshop on our newly developed network analytical approaches. These methods are data-driven network algorithms in R developed for looking at patterns in dominance and subordination, grooming, and how patterns in relationships map to individual and group level attributes (e.g., personality). Our research team will provide R code and/or packages for these methods and instruct members how to use them. We will offer three different methods: (1) percolation-conductance using a beta random field finds multi-step, directed pathways between all pairs of nodes to assess the global directional consistency of information flow between dyads; (2) data-cloud-geometry performs a random walk to identify clusters of nodes that are more similar to one another than they are to other clusters; and (3) joint-network-modeling examines the interdependent relationship between two or more behavioral (biological) networks containing the same nodes. Participants are expected to bring their own laptop computers with R downloaded. Our research team will provide information on how to prepare and load network datasets in R, as well as sample datasets for participants to practice with. However, participants are encouraged to bring their own network data to the workshop. This workshop likely will be of interest to ASP members studying all aspects of social behavior in study groups of >10 individuals.

3. ASP EDUCATION COMMITTEE PRE-CONFERENCE EDUCATIONAL OUTREACH

A. M. Dettmer¹, M. K. Hambright² and M. F. Novak³

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In service to the Education Committee's aim of promoting public education regarding primates, primate conservation and primate research, we are offering two pre-conference workshops in association with an Early Childhood Education Conference at Central Oregon Community College (COCC) for which participants may receive continuing educational credits. The first of these sessions will be a daylong workshop held on the COCC campus in May and is entitled "Beyond Curious George: Learning About Primates in Early Childhood Settings," and will be geared toward providing early childhood educators with activities and discussions suited to their students. The second session will be a half-day session held the opening morning at the conference venue and will cover topics including primate diversity, conservation, and the benefits of incorporating primatology in the K-12 curriculum.

15. PRELIMINARY OBSERVATIONS OF SOCIAL INTERACTIONS DURING SPONTANEOUS CUP TOOL USE BY CAPTIVE-BORN ADULT FEMALE SQUIRREL MONKEYS (*SAIMIRI SCIUREUS*)

C. L. Buckmaster, K. J. Parker and D. M. Lyons

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Behavior sampling was conducted to characterize spontaneous cup tool use by social-living female squirrel monkeys (N=20). Cup use involves using an object to contain food reduced by mouth into chewable pieces for eating. Of 63 cup use acts collected, 36% (N=23/63) included social interactions involving cup transfers between peers (monkeys=14, avg. acts/monkey=1.643 median=1, range=1,6). Analysis of video-captured cup transfers (N=15/23) revealed communicative signals such as mutual gaze, gaze alternation, and gesturing occurred during transfers. In humans and other primates such signals are thought to reflect non-verbal shared attention skills. Typical cup transfers involving communicative signals appeared as follows: 1) Monkey Ay approached cup-using peer Md, each watching the other. Md paused food-processing with the cup and made a release gesture, i.e., Md removed one hand from the cup and held it to the side of the cup. The two held mutual gaze as Ay grasped the cup and Md released it 2) Monkey Tw approached cup-using peer Ma. Tw alternated gaze from the cup, to Ma, then back to the cup, while making a 'requesting' gesture, i.e., Tw outreached her arm toward Ma and retracted it when Ma averted her gaze and body position in response. Tw grasped the cup when Ma redirected her gaze toward Tw. These observations suggest squirrel monkeys may share attention during cup tool transfers. Supported by NIMH and Pritzker Foundation.

16. IDENTIFICATION OF MICROSATELLITE LOCI TO INFER RED COLOBUS GENETIC STRUCTURE AMONG FRAGMENTS SURROUNDING KIBALE NATIONAL PARK

A. J. Hitchcock¹, M. J. Ruiz-Lopez², N. Simons³ and N. Ting^{1,2,3}

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The Ugandan red colobus monkey (*Procolobus rufomitratu tephrosceles*) is among the most endangered primates in the world due mainly to habitat loss, particularly outside of the protected areas. As a result, the populations are very fragmented and the movement of individuals between forests can be limited. The goal of this study was to optimize a panel of microsatellite loci to determine the population genetic structure of the Ugandan red colobus inhabiting the Kibale National Park region. We tested a total of 17 microsatellite loci previously used in humans in eight fecal samples and eight blood samples. All the markers were polymorphic but one of them showed a pattern that did not allow successful genotyping and was not used further. The remaining 16 markers had between 2 and 9 alleles (mean= 4.68), which matches previous studies of other red colobus populations. This set of markers has been further used to genotype 196 fecal samples and 95 blood samples from 5 fragments outside the park and 2 localities within the park, and is adequate to understand population structure in this species. Such information will be used to better understand which types of landscape features inhibit movement in this species and to understand the effects of human disturbance on disease transmission.

19. MONKEYS IN SPACE: GEOGRAPHY, ECOLOGY AND SOCIAL LIFE

L. Barrett

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Primate social life and behaviour is contingent on a number of levels -- phylogenetic, functional and proximate. Although this contingency is recognised by socioecological theory, variability in behaviour is still commonly viewed as “noise” around a central tendency, rather than as a source of information in its own right. Allied to this has been a tendency to assume that species can be adequately characterized by consideration of a representative group from a single population; a view that is becoming increasingly insecure. An alternative view is that selection has acted on social reaction norms that encompass demographic variation both between and within populations and demes. Here, using data from baboons and vervet monkeys, I illustrate how this alternative approach can provide a more nuanced account of social structure and its relation to contingent events at the ecological, demographic and phylogenetic level.

20. PREVALENCE OF ABNORMAL BEHAVIORS SURVEYED IN A POPULATION OF ZOO-HOUSED CHIMPANZEES

S. R. Ross

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Chimpanzees (*Pan troglodytes*) are a species for which the study of abnormal behavior is well-documented in a variety of captive environments. These behaviors are used to indicate a welfare problem though there is some ambiguity as to whether the simple presence of abnormal behavior or some measurable frequency of these patterns is the appropriate performance standard for captive environments. Birkett & Newton-Fisher (2011) concluded that abnormal behavior was endemic in zoo-housed chimpanzees (6 zoos, n=40). Here, we used survey methods to characterize the prevalence of abnormal behaviors over a more complete population of zoo-housed chimpanzees (30 zoos, n=235). Overall, 62% of this population was reported to have shown at least one abnormal behavior in the last two years compared to 100% in the previous paper. Both studies identified coprophagy and hair-plucking as the most prevalent abnormal behaviors though our data suggest they are less pervasive (coprophagy: 39% versus 81%; pluck: 32% versus 58%) than previously reported. Also differing from the previous analysis, we found the prevalence of abnormal behaviors was influenced by the origin of the individual (KW=8.13, p=0.04); zoo-housed chimpanzees from laboratories tended to show higher rates of these behaviors than those from other origins. These findings demonstrate the importance of a representative sample when characterizing a population's behavioral profile and aid our understanding of the prevalence of abnormal behaviors in this species.

22. PRESIDENT'S FORUM: LABORATORY RESEARCH WITH NONHUMAN PRIMATES: CONCEPTUAL, ETHICAL, AND REGULATORY ISSUES.J. Capitanio¹, A. Bennett² and J. McNulty³¹California National Primate Research Center, University of California, Davis, Davis, CA, 95616, USA, ²University of Wisconsin, Madison, ³University of Texas, Austin

The American Society of Primatologists, since its inception, has been a home to primatologists who study a wide range of questions in a variety of settings: research facilities, zoological parks, field, and sanctuaries, in order to produce new knowledge. Perhaps not surprisingly, the diversity of members' background, expertise, knowledge, and goals sometimes produces concerns, tension, and even conflict. In this session, we will focus on issues pertaining to laboratory research. Sometimes lost in the discussion is an understanding of the conceptual background for experimental studies of nonhuman primates in the laboratory (e.g., role of experimental methodology in "strong inference"), the ethical considerations that guide the use of animals in the laboratory (e.g., considerations of harm vs. benefit), and the regulatory environment under which laboratory research operates. It is our goal, with this panel, to raise these issues for discussion using a novel two-part format. The first part (one hour) will involve presentations on the three topics of conceptual background (John Capitanio), ethical issues (Allyson Bennett), and the regulatory environment (Justin McNulty). Following these presentations, there will be an opportunity for all to submit written questions anonymously, either in an on-site box or via the web. The panel members will group questions, and will hold a second hour-long discussion (approximately 24 hours after the first panel) to discuss questions and issues raised by meeting attendees.

24. INTERDISCIPLINARY SYMPOSIUM ON PRIMATE SOCIAL AND BIOLOGICAL NETWORKS

B. McCowan

Population Health & Reproduction, School of Veterinary Medicine, UC Davis, Davis, 95242, USA

Network analysis is ubiquitous in many different disciplines in mathematics, physics and biology because virtually all systems regardless of whether they are of technological or biological origin can be described in terms of having components that are connected via interactions. The network approach is relatively new to field of animal behavior in general and primate behavior in particular despite its considerable potential for explaining and predicting patterns and processes of social organization, cognition and communication. This symposium will bring together researchers from a number of disciplines with the aim of providing an overview of the power of the network approach for understanding emergent patterns and reciprocal processes in primate behavior. Presenters will apply social network theory to a variety of conceptual frameworks such as system stability, information transfer, collective behavior, health and disease, and phylogeny representing a diversity of taxa in both captivity and the field.

25. NETWORK DYNAMICS OF SOCIAL STABILITY

B. A. Beisner^{1,2}, H. Fushing³ and B. McCowan^{1,2}

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Social systems are composed of multiple constituent networks that interact, and stability is a system-level property that emerges from this interaction. Network theory is designed to reveal emergent structure in complex systems and identify potential sources of network instability. We describe here a data-driven network approach, called Joint Network Modeling (JNM), which

identifies changes in social stability by quantifying the relationships amongst these multiple constituent networks. To illustrate how JNM can detect instability in empirical networks of a complex system, we present analyses of the joint relationship between aggression and subordination networks in four stable and three unstable groups of rhesus macaques. All stable groups showed the same pattern of interdependence: 58-76% of the interdependence between aggression and subordination networks came from having far more dyads than expected (under the null hypothesis of independence) with opposite direction aggression and subordination, i.e., aggression always goes from A to B, and peaceful subordination signaling always goes from B to A. In unstable groups, however, less of the aggression-subordination network interdependence came from dyads with opposite direction aggression and subordination (38-51%). Furthermore, unstable groups had more frequent than expected dyads with ambiguous/contested dominance relationships (e.g. bidirectional aggression with either no subordination signals or bidirectional subordination). By revealing the hidden architecture of inter-network relationships, JNM readily distinguished stable from unstable phases across multiple replicates of a complex social system.

26. QUANTIFYING INFORMATION TRANSFER ACROSS SOCIAL NETWORKS: TOOLS, APPLICATIONS AND ECOLOGICAL IMPLICATIONS

D. R. Farine^{1,2,3} and W. Hoppitt⁴

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The patterns of individuals' social contacts can impact their fitness in a wide range of ways. One of the more challenging aspects when characterising the importance of network structure is to understand the impact it has on population processes, such as the spread of information. If information relies on inter-individual contacts in order to be transmitted, then this can have widespread implications for who will have access to it, how fast it spreads, and, ultimately, what information is successfully transmitted. I will introduce Network-based diffusion analysis (NBDA), a powerful method for quantifying rates and patterns of information transfer through social networks. I will illustrate this with examples of NBDA being applied in a range of systems to investigate the transfer of information ranging from the location of ephemeral food sources to novel foraging techniques and tool use. I will then discuss the different variants of NBDA that have recently been developed that vastly increase the power of this method for hypothesis testing. Finally, I will discuss ecological implications information transfer, such as its potential feedback on social network structure, and the effect of network structure on the rise and fall of different pieces of information.

27. COLLECTIVE MOVEMENT IN SOCIALLY AND ENVIRONMENTALLY HETEROGENEOUS SYSTEMS: A CASE STUDY IN OLIVE BABOONS

M. C. Crofoot^{1,2}, D. R. Farine^{1,2,3}, A. Strandburg-Peshkin⁴, I. Brugere⁵, J. Li⁵ and T. Y. Berger-Wolf⁵

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⁵Department of Computer Science, University of Illinois, Chicago

The study of how group behavior emerges from individual interaction rules is having a profound impact on our understanding of the mechanisms that shape collective phenotypes but there remains a significant gap between studies of collective behavior in laboratory settings and what we know about these processes in ecologically or socially relevant contexts. To investigate how differentiated social relationships and environmental heterogeneity shape collective behavior in animal groups, we captured simultaneous high-resolution GPS tracks from all members of a wild olive baboon troop (*Papio anubis*; 26 individuals sampled at 1 Hz). We infer network structure by applying machine learning to these data, and investigate how social and ecological conditions influence the spatial organization of groups. We then test how the connections between preferred social partners influence collective movement patterns. Finally, we explore the relative importance of individual relationships vs. majority rule in driving group movement decisions in this highly structured society. Combining fine-resolution continuous tracking data with novel network-based analyses provides a unique framework from which we identify mechanisms that contribute to social organization and elucidate how these integrate to form collective behavior.

28. A SOCIAL NETWORK PERSPECTIVE ON MACAQUE SOCIAL STYLES

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Macaque social structures vary along an intolerant-tolerant gradient of social styles. In intolerant macaques, social relationships are often strictly influenced by dominance hierarchies and kinship, whereas tolerant macaques show more flexibility regarding who interacts with whom and how. Variation in these social styles is thus likely to reflect variation in individual social and ecological strategies regarding cohesion, coordination, competition and cooperation, which ultimately feedback on the evolution of these differences. Social Network Analysis (SNA) offers a useful set of tools that take into account direct and indirect connections between individuals in a social network. SNA provides a novel multilayered perspective on macaque social style differences and their impact on biological processes. For this symposium, we review studies and present our own empirical work on the comparison of social network characteristics along a gradient of social styles. For example, compared to intolerant macaque social networks, those of tolerant macaques show lower modularity, lower variance in group members' centrality coefficients, and greater efficiency. We discuss how SNA provides further insight into how such differences can relate to various biological processes, such as patterns of reciprocity in the exchange of social services, or potential for disease/parasite transmission, and add further perspective on the evolution of divergent social styles.

29. INDIVIDUAL DIFFERENCES IN AFFECTIVE PROCESSING RELATE TO SOCIAL NETWORK STATUS: A PRELIMINARY STUDY

E. Bliss-Moreau^{1,2}, B. Beisner^{1,2}, G. Moadab^{1,2} and B. McCowan^{1,2}

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Accumulating evidence suggests the properties of human social networks influence individual's affective processing. We tested the hypothesis rhesus monkeys' (*Macaca mulatta*) roles in their networks (e.g., rank, dominance rank certainty [DRC]) were related to individual differences in affective processing. We measured 3-minutes of autonomic nervous system activity (ANS) data while monkeys were lightly sedated. ANS activity is thought to be critical for affective experience in humans (Barrett & Bliss-Moreau, 2009; Craig, 2009) and varies with affective states in monkeys (Bliss-Moreau, Machado, & Amaral, 2013). By recording both electrocardiogram and impedance-cardiogram we indexed activity in both branches of the ANS – the parasympathetic and sympathetic systems, typically thought of as the “rest-and-digest” and the “fight-or-flight” systems, respectively. Neither rank nor DRC predicted either parasympathetic or sympathetic activity for females (N=22). In contrast, rank and DRC were significant predictors of activity in both systems for male subjects (N=8) and explained substantial variance ($R^2_{\text{parasympathetic}}=.845$; $R^2_{\text{sympathetic}}=.887$). Higher rank and DRC were associated with lower parasympathetic (rank= -.793, $p_{\text{rank}}=.008$; DRC= -.755, $p_{\text{DRC}}=.009$) and higher sympathetic (rank= -.506, $p_{\text{rank}}=.020$; DRC= .964, $p_{\text{DRC}}=.001$) activity. Thus, high status males, even when they are certain of their ranks, are always physiologically primed to defend their social roles. In contrast, rank and DRC may not influence female physiology because females largely acquire/maintain their social roles via kin alliance relationships rather than their own competitive ability.

30. UTILIZING NOVEL OBJECT TEMPERAMENT TESTS TO IMPROVE ENRICHMENT PROVISION TO MACAQUES

S. L. Nelsen¹, J. Ha², D. Bradford¹ and P. Houghton¹

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²University of Washington

Studies have shown that there is a relationship between temperament and social housing, and temperament and operant conditioning training. When choosing enrichment for primates, it is common to base this upon species, age and behaviors. Until recently, temperament and enrichment have not been investigated. At Primate Products, 71 male Chinese macaques (*Macaca fascicularis*) were evaluated with novel object temperament tests. Once animals were separated into temperament categories of exploratory, moderate and inhibited, 45 were randomly assigned to 1 of 3 EE plans (control, low novel stimuli, and high novel stimuli) over 3 weeks. Each EE plan consisted of AM treat, non-food oriented enrichment and forage on turfboard. Effects of Time, EE Plan and Temperament were analyzed with a Repeated Measures, Two-Way ANOVA. For AM Treat, there was a significant effect for Temperament ($F=18.05$; $df=2, 36$; $p<0.0001$), but not Time or EE Plan, indicating that temperament is related to an animal's willingness to accept treats. For non-food oriented enrichment, there was a significant effect for Time ($F=4.76$; $df=5,160$; $p<0.0001$), but not EE Plan or Temperament, indicating that over time all will use non-food oriented enrichment. For forage on turfboard, there was a significant effect for Time ($F=14.209$; $df=5,185$; $p<0.0001$), EE Plan ($F=3.72$; $df=2,37$; $p=0.034$) and an interaction between Time and EE Plan ($F=3.72$; $df=2,37$; $p=0.034$), but not Temperament, indicating that something

else is effecting whether a macaque forages on turfboard, and this is more intensely effected by how novel the forage is.

31. ESTABLISHING THE RELIABILITY OF RHESUS MACAQUE SOCIAL NETWORK ASSESSMENT FROM VIDEO OBSERVATIONS

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Understanding the properties of a social environment is important for understanding the dynamics of social relationships. To quantify social environment properties, recent studies have incorporated social network analysis (SNA). SNA quantifies both the global and local properties of a social environment, such as social network efficiency and the roles played by specific individuals, respectively. Determining the amount of data necessary for a reliable network is critical for measuring changes in the social environment, for example following an experimental manipulation, and therefore may be critical for using SNA to statistically assess social behavior. We extend methods for measuring error in acquired data and determining the amount of data necessary to generate reliable social networks. We derived social networks from a group of 10 male *Macaca mulatta* (rhesus macaques) for three behaviors: spatial proximity, grooming, and mounting. Behaviors were coded using a video observation technique, where video cameras recorded the compound where the macaques resided. 10 hours of video data were collected, coded and used to construct these networks. Using the methods described here, we found in our data that one hour of spatial proximity observations produced reliable social networks. However, this may not be true for other studies due to differences in data acquisition. Our results have broad implications for measuring and predicting the amount of error in any social network, regardless of species.

32. MORE THAN JUST A NUMBERS GAME: POPULATIONS, NETWORKS, AND DISEASE DYNAMICS IN PRIMATES

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Living in larger, more complex social groups is assumed to increase disease risk in primates, yet empirical evidence is mixed on how group size or structure influence disease dynamics. We studied the networks of 42 primate social groups of varying size to test whether larger social groups displayed quantitatively different network structures than smaller ones, specifically through subdivision. If so, the social subdivisions that form in larger groups may act as barriers to the spread of infection, weakening the association between group size and infectious disease. To investigate this “social bottleneck” hypothesis, we examined the association between group size and four network structure metrics: modularity, clustering, distance, and centralization. Over a large set of PGLS results investigating these metrics, modularity showed positive

associations with group size, which was further supported in a meta-analysis of intraspecific variation among certain primate, as well as other mammal, reptile, and invertebrate species. We then used a theoretical model to introduce the effects of subgrouping to those of other factors that influence disease spread in socially structured populations. In this model, outbreaks reached higher prevalence when groups were larger, but subgrouping balanced this effect, reducing prevalence. Subgrouping also decreased the spread of disease from the index subgroup to other subgroups. Building on these theoretical and modeling results, we present suggestions for revising the relationship between group size and disease spread.

34. EVOLUTIONARY PERSPECTIVES ON BEHAVIOR, BONES, AND DEVELOPMENT

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Our goal in this symposium is to utilize both captive and wild primatological data to investigate evolutionary hypotheses. Evolutionary biology has recently renewed focus on development and organismal-level studies of the phenotype. The phenotype includes the behavior and bodies of an organism from conception through adulthood, and in primates also includes social realities as extended phenotypes. West-Eberhard (2003) argues it is the organism that must actually survive the local environment in order to reproduce, and therefore the phenotype is the most evolutionarily relevant unit of study. Primatology is ripe for such perspectives, as the field has always been largely phenotype focused. Studies presented here focus on behaviors that inform morphology, morphology that informs behavior, or both. We include current research on bonobo and lemur sociality, comparative morphology, comparative ontogenies, and ecologically driven phenotypic patterns in macaques and in gorillas. Such research on development, social complexities, and variation in phenotypic traits due to environmental pressures are particularly informative for testing evolutionary hypotheses. Integrated datasets on behavior, bones, and development allow us to stay relevant to fossil evidence, while also contributing valuable data on modern species. Opportunities to relate datasets and methods between sub-disciplines within primatology are exceedingly valuable, because comparative phenotypic research is necessary for advancing knowledge in primate, and human, evolution generally. References West-Eberhard, M. J. 2003. *Developmental Plasticity and Evolution*. Oxford University Press.

35. THE ADVANCEMENT OF THE MODERN PRIMATE SANCTUARY AND THE GROWTH OF COLLABORATIVE OPPORTUNITIES

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In recent years, the primate sanctuary community has grown not only in terms of population capacity but also in professional development. Many modern sanctuaries are accredited, non-profit organizations with well-organized care staff, veterinary support, and fundraising strategies that help support their mission to provide lifetime care for primates retired from research laboratories and private ownership (pets and performers). A historic divide between the range of organizations housing primates (zoos, sanctuaries, laboratories) is now lessening and there is growing consensus that cooperative and collaborative approaches have a range of positive

outcomes for the organizations involved and ultimately, for the primates in our care. In this symposium, a range of speakers from the research, zoo and sanctuary communities will describe the evolution of primate sanctuaries and outline how professional and collaborative partnerships can be a productive and successful means to improve the lives of captive primates and our understanding of them.

37. HAIR CORTISOL IS ASSOCIATED WITH CHANGES IN HAIR LOSS AND BODY CONDITION ACROSS PUBERTY IN MALE RHESUS MONKEYS

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Puberty in primates is a period of marked physiological and physical changes, yet little is known about how chronic levels of hormones relate to physical changes during this transition. We conducted a cross-sectional study of 60 rhesus macaques (*Macaca mulatta*, 40 female) between 2-4 years of age to examine hair cortisol concentrations (HCCs) as they relate to veterinary assessments of hair loss, body condition, body scores, and lymph node condition. Results of multivariate ANOVA revealed that males and females showed divergent scores on all physical measures except body score ($0.008 < p < 0.045$), with females overall exhibiting poorer condition between 2-3 years of age and males exhibiting poorer condition between 3-4 years of age, concurrent with the timing of puberty for each sex. Pearson correlations revealed that for males only, higher HCCs were correlated with greater hair loss ($r=0.62$, $p<0.05$) and greater lymph node enlargement ($r=0.76$, $p<0.01$). These associations between higher chronic circulating glucocorticoids and markers of immune function may shed light on the increased risk of mortality in juvenile male monkeys. Moreover, these findings underscore the utility of HCCs for identifying individuals at risk for adverse health outcomes related to pubertal changes in primates.

38. TESTING THE VARIABILITY SELECTION HYPOTHESIS IN MACAQUES

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The Variability Selection Hypothesis (VSH) proposes that early *Homo* gained adaptive benefit from being versatile in unpredictable climates. Greater intra-taxon variation in body size of early, then later, *Homo* populations suggests increased developmental plasticity. Extant *Macaca* is an ideal taxa in which to examine the VSH because they are known to have broad geographic, niche, and dietary ranges. If ecological flexibility predicts developmental plasticity, then we predict macaques to be as variable as modern humans in developmental markers. We used established developmental osteological markers (dental eruption and long bone epiphyseal fusion); original data was collected on *Macaca mulatta* specimens ($n=292$) and compared to published data from human populations ($n>25000$). Two-way anovas without replication were used to test whether species had similar variation in dental eruption and fusion time. The two species had significantly different eruption variation (males $F=33.71$, $df=15,1$, $p < 0.0001$; females $F=119.06$, $df=15,1$, $p < 0.0001$) with macaques being more variable than humans. The two species also had different

ranges in fusion time ($F=7.28$, $df=13,1$, $p < 0.5$) with macaque males being more variable than human males. Variation in the onset and duration of these developmental markers is indicative of phenotypic plasticity, and this preliminary data indicates macaques are as plastic as humans. Additionally, the similarity in ecological profiles between taxa supports the idea that some macaque species may be under variability selection.

39. THE EVOLUTION OF PRIMATE SANCTUARIES IN THE UNITED STATES

E. W. Fleury

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The recent history of policy change surrounding non-human primates in research laboratories has led to the decline in the use of these species over the past several years. This, in turn, has led to the necessity of reputable facilities to house these animals upon retirement and the need to address the financial responsibility that comes with caring for these animals for the remainder of their lives. As the sanctuary community has grown, so has the concern for regulation and standardization of care and management practices in these facilities. Organizations such as the North American Primate Sanctuary Alliance (NAPSA) and the Global Federation of Animal Sanctuaries (GFAS) have been established to establish, maintain and regulate the standards and guidelines that guide our collective management practices and provide the necessary oversight to ensure that retired primates receive the appropriate level of care. In this talk, we will provide an overview of the recent history for the U.S. sanctuary community and describe the growing breadth of opportunities for sanctuaries to work with partners and stakeholders to provide lifetime, sustainable care to primates.

40. RANK AND DOMINANCE UNCERTAINTY INFLUENCE PRO-INFLAMMATORY CYTOKINE AND VIRAL ANTIBODY LEVELS IN RHESUS MACAQUES (*MACACA MULATTA*)

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Both low social status and unpredictability have been associated with negative health outcomes in humans and non-human primates. Because unpredictability and low social status often co-occur, it is difficult to disentangle their independent contributions to health. We used social network techniques to quantify dominance rank and certainty in dominance relationships to examine their impact on pro-inflammatory cytokine levels and latent virus reactivation. We observed two large outdoor social groups of rhesus macaques ($N=139$) for 6 weeks at the California National Primate Research Center. Multi-level models were selected based on AIC ($\alpha=0.05$). High rank was associated with higher IgG levels for herpes B and rhCMV, while for IL-6, mid-ranked animals' levels were lower than those of either high- or low-ranked animals. Animals with more ambiguous dominance relationships had higher IgG for herpes B, CMV, and higher IL-6. We also found two significant interactions between rank and dominance certainty: 1) higher rank was associated with higher Lymphocryptovirus IgG levels, but only for animals with more ambiguous dominance relationships, and 2) lower rank was associated with higher levels of TNF- α for animals with more certain dominance relationships whereas a small but opposite effect was true for animals with

ambiguous dominance relationships. These results demonstrate that the impact of social status on health depends, in part, on the certainty of social relationships.

41. COMMUNITIES OR CLIQUES? A REEXAMINATION OF BONOBO SOCIAL ORGANIZATION

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If we consider social behavior as part of an individual's phenotype, than the differences observed between bonobos (*Pan paniscus*) and chimpanzees (*Pan troglodytes*) are important for understanding the selective forces that have influenced human evolution. Chimpanzees live in "communities" that vary in size, composition, and levels of bonding, but are generally characterized by discrete territories defended by highly bonded male kinship groups. The bonds observed among chimpanzee females vary, but are generally weaker than those bonds observed among males. Bonobos also live in "communities". Yet despite the shared nomenclature, research on bonobo social behavior has revealed several differences when compared with chimpanzees. Adult males are commonly found ranging together with their mothers or independently and lack tight bonds with other males. Furthermore, evidence from several sites suggests males can successfully transfer between groups. Unrelated adult females are far more social than most chimpanzee females and constitute the core of bonobo social groups, which we call "cliques". For example, at Lomako, females were more closely associated with each other (mean Jacob's Index = .251) than were the males (mean Jacob's Index = .0527). And while both species' social groups will break apart and come together depending on a number of factors, evidence from the field suggests that bonobo cliques may be more stable in the short term and more fluid over longer periods of time.

42. RESEARCH RETIREMENT: BRIDGING THE GAP BETWEEN RESEARCH AND SANCTUARY

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According to the Animal Usage by Research Facilities report compiled by the USDA, there were 64,107 non-human primates used in research, testing, teaching and/or experimentation during Fiscal Year 2013. Due to a range of factors, there is a growing impetus to retire former lab-housed monkeys to sanctuary settings where they can receive appropriate care outside of their use in research. Jungle Friends Primate Sanctuary, an accredited primate sanctuary in Florida, recognized an opportunity to bridge the gap between the research and sanctuary communities to create a transparent and mutually beneficial process by which researchers could retire monkeys no longer needed for science. Today, there are over 200 monkeys housed at the facility including capuchins, squirrel monkeys, marmosets and tamarins, many of which were retired from university-based laboratories. In this presentation, we will describe the proven process by which researchers and sanctuaries can work cooperatively toward a common goal of safe and sustainable retirement for these monkeys. Consideration of important policy (licensing, accreditation); communication (confidentiality, publicity); financial (care costs, construction) and management (transportation,

socialization) factors is essential to ensuring that all stakeholders are satisfied with the results of this important collaborative process. The success of this model can be of use to researchers and managers seeking to retire their research subjects in the future.

43. OXYTOCIN AND SOCIAL BUFFERING IN MARMOSETS

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Social disruption, isolation, and neglect are a major source of stress and can negatively impact hypothalamic-pituitary-adrenal (HPA) axis functioning in socially monogamous primates; while social support has stress-reducing effects through HPA-axis modulation (Cohen & Wills, 1985). Oxytocin (OXT) plays a critical role in the facilitation of social bonding (Young & Wang, 2004) and may attenuate the bio-behavioral stress response (Smith & Wang, 2012). The goal of the present study was to determine if OXT plays a regulatory role in the social buffering of HPA-axis activity during stress in well-established marmoset (*Callithrix jacchus*) pairs. Male and female marmosets (n=10) experienced a standardized psychosocial stressor with and without their pair-mate under neuropeptide treatment (Pro8-OXT, Leu8-OXT, OXT antagonist, and saline). Male, but not female, marmosets treated with an OXT antagonist had significantly higher HPA-axis reactivity [$F_{(3,12)}=6.88$, $p=0.006$] and total cortisol exposure across the stressor period, relative to vehicle [$F_{(3,12)}=9.59$, $p=0.002$]. Female, but not male, marmosets that experienced a stressor with their pair-mate had significantly lower HPA-axis reactivity [$F_{(1,4)}=7.07$, $p=0.05$] and total cortisol exposure across the stressor period than females without their pair-mate [$F_{(1,4)}=13.87$, $p=0.02$]. These results suggest that endogenous OXT attenuates the stressor-induced rise in cortisol levels in male marmosets, while the presence of a pair-mate buffers HPA-axis activity in females. Thus, the OXT system and social context differentially influence how the HPA-axis responds to stress in male-female marmoset pairs.

44. A REASSESSMENT OF THE PHYLOGEOGRAPHY OF THE SULAWESI MACAQUES BASED ON 3D GEOMETRIC MORPHOMETRICS

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The number of recognized *Macaca* species on the Indonesian island of Sulawesi has varied depending on the methods used. This study applies landmark-based geometric morphometrics and various multivariate analyses to reassess the diversity of macaques on the island. Forty-five three-dimensional landmarks were recorded using a Microscribe 3D-X on 229 wild caught macaque cranial specimens representing 17 species, including 5 Sulawesi (sub)species with known localities from several museum collections. Generalized Procrustes analysis (GPA) was used to superimpose the landmark configurations and scale them to the same size. Principle components analysis (PCA), regression analysis, and Procrustes distances were used to compare shape differences within and among (sub)species and assess the amount of variance associated with different factors. Each analysis was performed on the total sample, as well as separately for each sex. Allometry accounted for the largest amount of cranial shape variation, with differences among taxa being the next most important factor. Variation among Sulawesi taxa was not different from that among the non-Sulawesi species which suggests a species-level of variation for the seven recognized

varieties. Males and females both show patterns of morphological similarity consistent with allopatric sub-speciation likely related to the island's geological history and distinct ecological zones. Although further analyses are necessary, these results support the seven-species model complementing previous genetic studies and designations based on soft tissue morphology in the Sulawesi macaques.

45. WHAT ENABLES A UNIVERSITY TO WORK EFFECTIVELY WITH A PRIVATE SANCTUARY TO RETIRE NONHUMAN PRIMATES

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University personnel and directors of private sanctuaries must navigate several challenges to retire nonhuman primates from laboratories to sanctuaries. We describe how people at the University of Georgia and Jungle Friends Sanctuary recently accomplished retiring a colony of monkeys. Three features of the sanctuary were critical to the University's ability to partner with Jungle Friends. First, the university ascertained that the sanctuary would provide appropriate high-quality care to the species under consideration. Second, the university determined that Jungle Friends had adequate financial resources and planning to provide life-time care for the number of monkeys that would be transferred to them. Third, the university was satisfied that it would receive positive media exposure from Jungle Friends for the transfer, and that it could partner with Jungle Friends for joint benefit in this effort. The individual investigating the possibility of retiring primates in his/her institution's care to a private sanctuary should be prepared to provide information about these features to the university, and for the sanctuary, to confirm that the university will actively assist with the expenses and logistics of the transfer process. We discuss how the individual researcher can learn about the relevant features of the sanctuary and the university, ways to present this information effectively to the two entities, and ways to enhance mutual benefits to the retirees, sanctuary and university from a retirement project.

46. OXYTOCIN, TESTOSTERONE, AND THE INITIATION OF AGGRESSION IN BONOBO (PAN PANISCUS)

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Testosterone has been connected to competition and reproductive success through its facilitation of competitive behaviors. Known as the 'Challenge-Hypothesis,' research on numerous species supports the connection between circulating levels of testosterone and aggression. However, in some species including bonobos, alternate strategies such as male-female affiliation confer greater selective advantage and testosterone is not always correlated with rank or aggression. Although recent data suggest a connection between affiliative behaviors and oxytocin in bonobos, less is known about the relationship between aggression, oxytocin, and testosterone. This study presents data on aggression, oxytocin, and testosterone in the Columbus-Zoo bonobos (N=16 individuals, N=91 urine samples). Mean urinary testosterone was positively correlated with rank for females ($p < 0.05$) but not for males ($p = 0.396$). Although there was no relationship between testosterone and participation in aggressive dyads ($p = 0.239$), testosterone levels were positively correlated with initiation of aggression ($p < 0.05$). Conversely, mean urinary oxytocin

levels were negatively correlated with participation in aggressive dyads ($p < 0.05$) and with initiation of aggression ($p < 0.01$). In females, initiation of aggression was not correlated with testosterone ($p = 0.734$) but was negatively correlated with oxytocin ($p < 0.05$), whereas in males, initiation of aggression was positively correlated with testosterone ($p < 0.05$) but not with oxytocin ($p = 0.0965$). These data support the hypothesis that testosterone facilitates some competitive behaviors, in particular the initiation of aggression in males, and suggest an inverse relationship between oxytocin and aggression in bonobos.

47. COMPARISON OF MEASURES OF INTER-INDIVIDUAL AFFILIATION AMONG RING-TAILED LEMURS (*LEMUR CATTALINA*)

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Primatologists use a number of behavioral measures to assess patterns of affiliation and aggression in groups of primates. These patterns can, however, vary greatly within a species with behavioral context. Lemurs, for example, are well known for the importance of context in the variation of aggression in feeding and non-feeding contexts as seen in both female dominance and female feeding priority. This study examined whether there are also variations in affiliation between feeding and non-feeding contexts. One of these measures, grooming, is widely accepted as a mechanism for social bonding, but it is not an appropriate measure for affiliation during feeding. We therefore used co-feeding as a measure of affiliation during feeding. We then used a non-parametric multivariate statistical comparison to see if the patterns of affiliation are consistent between these two contexts. We studied a group of semi-free-ranging ring-tailed lemurs on St. Catherine's Island, Georgia and collected 188 hours of behavioral data. Observations used focal animal sampling and all occurrence sampling of social behavior. We calculated indices for grooming and co-feeding for all possible pairs of individuals. A Mantel test was used to determine the correlation between the two affiliative measures. We found a significant correlation between our measures ($r = 0.7509$, $t = 8.635$, $p < 0.0001$). These results demonstrate that, affiliation patterns seen in non-feeding contexts are consistent with affiliation during feeding.

48. CHALLENGES ASSOCIATED WITH INITIATING A NEW SANCTUARY FOR OLD WORLD PRIMATES

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Old world monkeys such as macaques and baboons make up the vast majority of primates utilized in the research community. For a variety of economic, political and policy reasons, there has been a recent rise in the number of organizations seeking to retire these animals and as such an increased demand for high-quality and sustainable sanctuary space. The sanctuary has grown in carefully measured increments since its inception, due in part to the understanding of the need for a strong financial base to ensure sustainability. In this talk, I will discuss the process of determining the feasibility for creating the sanctuary, and the critical decisions that shaped the organizational structure. Working with laboratory managers and scientists, the sanctuary has identified hundreds of potentially-retireable monkeys and here I will discuss how these decisions

are made and what tangible restrictions limit future growth in this area. Special attention will be given to the specific challenges in managing these species. Through transparent negotiations and a conservative growth strategy, it is possible to work productively between and across stakeholder groups to meet the lifetime needs of the primates that require our help.

50. PROLACTIN AND OXYTOCIN: INTERACTIONS AND DUAL ROLES

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Prolactin and oxytocin serve many different functions. Both are involved in breastfeeding by promoting lactation (prolactin) and release of milk (oxytocin), mother-infant bonding and possibly, pair bonding. Although both hormones have been studied extensively in parenting, prolactin's role in pair bonding behaviors has not. We examined oxytocin, prolactin and behavior in male-female pairs of cotton-top tamarins (*Saguinus oedipus*) across the ovulatory cycle to determine if urinary prolactin and oxytocin were associated with affiliative and sexual behavior. Prolactin levels of males and females were similar within pairs ($Rsq=0.68$, $N=11$, $P=0.02$), and variation was explained by the amount of sexual behavior ($Rsq=0.76$, $N=11$, $P=0.02$) and contact affiliation ($Rsq=0.71$, $N=8$, $P=0.05$) in males. In females, variation was explained by contact affiliation ($Rsq=0.58$, $N=19$, $P=0.01$). Oxytocin levels were similar within pairs ($Rsq=0.71$, $N=14$, $P=0.02$) and the variation for both sexes was explained by the amount of affiliative behavior ($Rsq=0.78$, $N=14$, $P<0.01$) and for males also by the amount of sexual behaviors ($F_{(3,10)}=21.54$, $P=0.001$). Both oxytocin and prolactin are associated with sexual and affiliative behaviors in paired tamarins. To examine the release of prolactin and oxytocin, we examined hypothalamic explants in male paternally experienced and naïve common marmosets, *Callithrix jacchus*. Prolactin and oxytocin levels were elevated more in the explants from paternal males than in parentally naïve males. Both prolactin and oxytocin reflect social bonding in cooperatively breeding monkeys.

51. PROMOTING A SUCCESSFUL TRANSPORTATION AND RELOCATION PROCESS FOR CAPTIVE CHIMPANZEES (PAN TROGLODYTES)

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The successful transfer of chimpanzees between facilities involves more than simply loading the animals into a transportation vehicle. Transportation and relocation affect a variety of physiological parameters that are indicative of animal welfare; effects that can persist for up to 3 months. We will describe the steps that are necessary to ensure that the health and wellbeing of transferred chimpanzees are maintained during, and after, relocation. The process begins with the critical task of choosing individuals for relocation, including consideration of age, health, potential social group disruptions, and special needs. The transferring facility must share a variety of animal-related information, including not only complete medical records, but also behavioral profiles, social tendencies (with people and chimpanzees), training histories, diet information, distinguishing characteristics/habits, and special care requirements. Aging animals with mobility issues may require modifications to enclosure space or husbandry practices to maximize

wellbeing. Forethought and planning may enable the transferring facility to modify social groups prior to transport, eliminating many social factors from the variables that animals will need to adapt to at the new facility. Those caring for chimpanzees are committed and dedicated to 'their' animals, making it imperative that channels of communication between old and new facilities remain open before, during, and after relocation. Commitment to this process will minimize transfer-related disruptions to the lives of the chimpanzees and their human caregivers.

52. BERGMANN'S RULE IN SKULL SIZE AND CLINAL VARIATION IN SKULL SHAPE OF WILD VS. CAPTIVE *FASCICULARIS* GROUP MACAQUES

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Bergmann's rule predicts that body size increases with distance from the equator. This pattern has been noted in wild macaque populations, but relocated captive populations have not yet been examined for the cline. They are therefore a prime population for analyzing whether Bergmann's rule is influenced more by natural selection or developmental plasticity. Forty-five 3D cranial landmarks were collected using a Microscribe-3DX on a sample of 251 adult crania from wild populations of *Macaca fascicularis*, *M. cyclopis*, *M. fuscata* and *M. mulatta* with known provenience, as well as 18 captive *M. mulatta* from Beaverton, OR (lat=45.5) and 40 from Cayo Santiago, Puerto Rico (lat=18.2). Centroid size was calculated for each specimen as a proxy measure of body size. Shape was assessed with a 2-Block Partial Least Squares (2B-PLS) analysis between geographic and shape coordinates. Centroid sizes and 2B-PLS scores were regressed against the distance from the equator. For wild macaques, distance from the equator was significantly correlated with both size (males $R^2=0.370$; $p=0.00$; females $R^2=0.475$; $p=0.00$) and shape (males $R^2=0.529$, $p=0.00$; females $R^2=0.504$, $p=0.00$). Predicted latitudes based on cranial sizes (Beaverton=38.0; Cayo Santiago=44.9) were much larger than their respective current locations but were much smaller when based on shape (Cayo Santiago=13.3; Beaverton=8.5). These results suggest that phenotypic plasticity may play an important role in the latitudinal pattern of skull size in wild *fascicularis* group macaques.

53. EARLY REARING EXPERIENCE MODULATES TEMPERAMENT AND ACTIVITY OF THE OXYTOCIN SYSTEM AND HYPOTHALAMIC-PITUITARY-ADRENOCORTICAL (HPA) AXIS IN INFANT RHESUS MONKEYS (*MACACA MULATTA*)

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Early life is a critical period of neuroendocrine development. In macaques, nursery rearing has been shown to dysregulate hypothalamic-pituitary-adrenocortical (HPA) axis activity. Yet, little is known about how rearing experience modifies other neuroendocrine systems, such as the oxytocin system. To assess oxytocin and cortisol concentrations, hair, plasma, and cerebrospinal fluid were collected during routine health exams from 120 (68 male) infant rhesus monkeys (*Macaca mulatta*) randomly assigned to mother-peer reared (MPR), surrogate-peer reared (SPR), or peer-

only reared (PR) conditions. As expected, SPR and PR infants had lower plasma cortisol levels on day 14 ($F(2)=16.460$, $p<0.001$) and day 30 ($F(2)=11.025$, $p<0.001$) and lower hair cortisol at 6 months of age ($F(2)=4.419$, $p=0.015$) than MPR infants. Surrogate-peer reared infants had higher plasma oxytocin levels on day 30 ($F(2)=3.847$, $p=0.029$) than PR and MPR infants. Temperament, evaluated during the Brazelton Neonatal Assessment (BNAS), was also modified by rearing. Mother-peer reared infants were more reactive ($F(2)=63.985$, $p<0.001$), less consolable ($F(2)=157.966$, $p<0.001$), and less able to sooth themselves ($F(2)=150.608$, $p<0.001$) while PR infants were more fearful ($F(2)=5.480$, $p=0.005$). Blunted plasma cortisol levels in SPR and PR infants support previous reports of dysregulated HPA axis activity in nursery reared monkeys. For SPR monkeys, the oxytocin system may be altered by early experience. Results of the BNAS suggest that MPR infants may respond more reactively to maternal separation and behavioral testing.

54. THE RETIREMENT AND INTEGRATION OF FORMER LABORATORY-HOUSED CHIMPANZEES (*PAN TROGLODYTES*) AT CHIMP HAVEN

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In 2011, the National Academy of Sciences and the National Research Council concluded that chimpanzees were no longer necessary for most biomedical research. The decision led to the retirement of 115 additional chimpanzees to Chimp Haven, Inc. in 2013 and 2014 (50 males, 65 females, mean age=24.7, range 2-53) from three different facilities. Ninety-nine of the chimpanzees have been integrated into 14 pre-existing groups with an average group size of 10.64 (range 4-23). Others ($n = 16$) have not been integrated due to viral status or space availability. The process of accepting chimpanzees begins months prior to their actual arrival at Chimp Haven with positive communication between the National Institutes of Health, the sending laboratory, and Chimp Haven all being important factors leading to successful retirement. Both medical and behavioral records are sent by the sending institution and reviewed by Chimp Haven staff members. The laboratory and sanctuary work together to decide on space available for quarantine procedures and tentative dates for shipment which are then shared with the shipper. Staff members from the sending laboratory often accompany the chimpanzees to ease their transition to the sanctuary. The entire process of retiring the chimpanzees requires collaboration and cooperation between diverse groups of people and the socialization process requires the support and involvement of the behavioral, veterinary, and husbandry staff at Chimp Haven.

55. LATERALITY OF GROOMING AND TOOL USE IN A GROUP OF CAPTIVE BONOBO (*PAN PANISCUS*)

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Laterality has been intensively studied in non-human primates over the past few decades. We investigated the laterality of grooming and tool use in a group of captive bonobos. Grooming is considered a model behavior to investigate laterality as it is frequent and occurs in both the wild and captivity. Left hand bias has been previously reported for termite fishing in wild chimpanzees.

Subjects were 16 bonobos housed at the Columbus Zoo and Aquarium. Laterality of grooming was recorded using group scans; tool use was recorded using all-occurrence sampling. Behaviors were characterized as unimanual or bimanual and scored as right handed or left handed. Laterality was determined using a two-tailed binomial test with a level of significance of 0.05. We found no significant differences in unimanual or bimanual grooming in this group of bonobos. For the nine subjects who engaged in termite fishing with enough bouts for statistical testing, eight individuals exhibited significant laterality and strong individual hand preference, 5 subjects preferred their left hand and 3 preferred their right. Grooming was not lateralized in this population, yet a more complex behavior revealed individual hand preference. Our preliminary results for this group is similar to that for a larger group of bonobos (Chapelaine et al. 2011) who showed strong individual preference on a bimanual task, the tube task, but no group bias.

56. GENETIC REGULATION OF HIPPOCAMPAL SIZE TRAIT IN VERVET MONKEYS

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Little is known about the quantitative trait loci (QTL) underlying inter-individual differences in brain anatomy. As trait-associated genetic variants are more likely expression quantitative trait loci (eQTL), we proposed that genetic mapping of the QTL underlying brain anatomical traits would benefit from the parallel identification of eQTL in the brain. We employed this two-prong approach to identify the loci contributing to natural variations in hippocampal size among vervet monkeys (*Chlorocebus aethiops sabaues*). We conducted QTL mapping of the MRI-based hippocampal size (N = 347, Fears et al., 2009) and hippocampal gene expression measured with RNA-seq (N=59) in vervets from the Vervet Research Colony that had genotype data from the association mapping SNP set (~500K SNPs) and linkage mapping SNP set (~148K SNPs). Hippocampal size QTL were localized by linkage mapping with SOLAR, and hippocampal tissue eQTL were localized using an association analysis in EMMAX. We found an ~8-Mb long QTL region on vervet chromosome 18 significantly linked to hippocampal volume trait. Within this region, we identified two local eQTL regulating the expressions of two novel long intergenic non-coding RNAs (lincRNAs): LOC103222769 and LOC103222771 in the hippocampus. The co-localization of hippocampal lincRNA eQTL within the QTL for hippocampal size implicates this genomic region in hippocampal biology.

57. TOWARD A COMMON GOAL: OPPORTUNITIES FOR COLLABORATION BETWEEN PRIMATE SANCTUARIES AND UNIVERSITIES

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While sanctuaries and universities have been working together for decades, the recent growth of primate sanctuaries in North America and continuing student interest in primate behavior have created an opportunity to formalize these relationships into ongoing, collaborative programs. By partnering with universities, sanctuaries are able to draw upon the expertise of university faculty in fields such as primate behavior, nonprofit management, and education, and are provided with a pool of motivated student interns with academic training in the field. Universities, in turn, are able to provide their students with hands on training and, in many cases, opportunities for noninvasive studies. Both groups benefit from the increased interest and exposure that their partnership provides. In this presentation, we will describe the benefits of growing partnerships between Central Washington University, Fauna Foundation, and Chimpanzee Sanctuary Northwest, and between McGill University and Fauna Foundation.

58. MORPHOLOGICAL SIGNALS AND MATING SYSTEMS: COMPARING MEASURES OF CRANIAL FLUCTUATING ASYMMETRY AND SECOND-TO-FOURTH DIGIT RATIO IN PRIMATES

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Fluctuating Asymmetry (FA) has been hypothesized to be related to testosterone levels and mating strategies; typically males are more asymmetrical than females. Second-to-fourth digit ratio (2D:4D) is correlated with developmental testosterone levels. Using 2D:4D and cranial FA from 19 primates, we compare the relationship between these variables to their respective mating systems. Forty-five landmarks were digitized using a Microscribe-3DX© for 345 male and 307 female crania. Cranial FA was measured by calculating the Procrustes' distance between each individual and its mirror-image. Mating systems, classified by intensity and frequency of male aggression, and sex-specific 2D:4D were taken from published studies. Cranial FA and 2D:4D were compared using parametric correlation. Two-way ANOVA of sex and species with *a priori* multiple comparisons between mating systems was used to examine variation in individual FA. Cranial FA and 2D:4D were correlated ($r=-0.460, P<0.05$). Cranial FA significantly differed among species ($F=64.84, N=19, P<0.05$), but there was no difference between sexes ($F=1.08, ns$) and no sex-species interaction ($F=1.24, ns$). Multiple comparisons grouping species by mating systems within this ANOVA showed significant differences between pair-bonded and non-pair bonded ($F=30.79, P<0.05$), between low intensity and high intensity ($F=136.76, P<0.05$) within non-pair bonded, and between low frequency and high frequency ($F=154.62, P<0.05$) within high intensity and non-pair bonded. These results support the hypothesis that cranial FA is correlated with testosterone and the variance in male aggression among mating systems.

59. CAPTIVE BONOBO URINARY CORTISOL FOLLOWS DIURNAL RHYTHM: IMPLICATIONS FOR PRIMATE SOCIO-ENDOCRINOLOGY RESEARCH

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Humans produce cortisol, a glucocorticoid hormone, in a circadian rhythm that follows a standard pattern of spiking within approximately 30 minutes of waking and then slowly dropping back to baseline throughout the day. A dysregulation in this pattern is linked to stress and negative health outcomes in humans. Studies are beginning to examine cortisol in bonobos, but few studies have characterized whether or not their daily cortisol concentrations also exhibit a similar circadian rhythm. We hypothesized that bonobos would follow a similar diurnal rhythm. Urinary cortisol samples from a captive population of bonobos at the Columbus Zoo and Aquarium (N = 13; 6 male, 7 female) were analyzed for free cortisol concentration by enzyme immuno-assay (Arbor Assays, Ann Arbor, MI) and normalized to mg creatinine. Four samples per individual (2 morning and 2 evening) were assayed and mean morning and evening values were calculated. Mean morning concentrations were significantly higher than evening values ($p < 0.01$). In all but two individuals, samples followed the diurnal pattern of higher morning than evening concentrations. The two individuals with a dysregulated pattern of cortisol concentration are among the lowest ranking bonobos in the group. Including diurnal rhythm considerations in this type of research has multiple implications for the study of stress behaviors and captive management of primates.

60. OPPORTUNITIES AND CHALLENGES IN REALIZING THE RESEARCH POTENTIAL OF SANCTUARIES

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It is likely that in the next few years, chimpanzees living in sanctuaries will, for the first time, outnumber those living in research centers and universities. This shift has caused concern for some who remain invested in learning about chimpanzee biology and behavior because traditionally, sanctuaries have relatively little involvement in research. There are however, a growing number of research opportunities developing in non-traditional settings such as sanctuaries, and the potential for non-invasive scientific work is vast. I will describe a number of productive research outcomes that have involved sanctuary-housed chimpanzees and the manner in which sanctuaries and scientists can build mutually beneficial partnerships that increase our knowledge of this important species while respecting the core mission of sanctuary settings. By evaluating the concerns and challenges, real and perceived, to these collaborations, scientists will be better equipped to create and maintain positive and productive relationships with sanctuary organizations.

61. MIND OVER MATTER: AN ONTOGENETIC PERSPECTIVE

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The Growth Regulatory Hypothesis states that brain growth governs somatic growth. Muscle as a percentage of body mass (%TBM) varies during adulthood, but the amount of variation in muscle as a %TBM is most notable during early development. In humans, there is a marked inverse relationship between the rate of growth (and glucose consumption) in the brain and the rate of growth in skeletal muscle, with a pronounced shift in resource allocation directly preceding

puberty. This shift occurs because early in life, brain growth is the focus of glucose consumption. This study evaluates if a similar relationship can be found in non-human primates. We dissected an ontogenetic sample of primates: *Galago*, *Hapalemur*, *Saimiri*, and *Pan*. We collected total muscle mass values and endocranial volume. Using molar eruption as a marker of adult brain size in subadults, we examined how muscle mass as a %TBM changes as individuals age. We observed a shift in muscle mass soon after the first lower molar erupts. In *Pan*, muscle as a %TBM averages 18% early in life, while it averaged 35% in adults. The same pattern was seen in *Galago* (10.1% vs. 36.7%), *Hapalemur* (11.2% vs. 24.2%), and *Saimiri* (9.1% vs. 29.3%). Examining how muscle mass changes ontogenetically is another method of evaluating the proposed metabolic trade-off between brain size and muscle mass.

62. VARIATION IN MALE AGGRESSIVENESS BETWEEN WILD CHACMA BABOONS IN BOTSWANA AND GUINEA BABOONS IN SENEGAL AND THEIR RELATION TO FT AND FGC PATTERNS

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Males usually compete aggressively over access to females, but male aggressiveness varies among species. Because testosterone levels can affect aggressiveness, interspecific variation in aggressiveness might be linked to differential testosterone (T) patterns. Furthermore, glucocorticoid (GC) patterns vary among species because individuals' allostatic loads depend on the type and intensity of competition. Chacma (*Papio ursinus*) and Guinea baboons (*P. papio*) differ in several aspects of their social systems and hence represent a good model to investigate the causes and endocrinological correlates of variation in male aggressiveness. We conducted focal observations on wild chacma baboons in Botswana (N=11 males, 260h) and Guinea baboons in Senegal (N=14 males; 231h), and collected fecal samples (N=258 and N=269, respectively) to determine fT and fGC levels. Male chacma baboons were more aggressive than male Guinea baboons (Wilcoxon-Mann-Whitney test: $P < 0.001$), and male chacma baboons with high fT levels showed more frequent agonistic behaviors (Chisq=5.567, Df=1, $P = 0.018$). Dominance relationships were more consistent in chacma baboons, and we could not detect ranks in Guinea baboons. High-ranking male chacma baboons showed higher fGC levels than low ranking males (Chisq=4.759, Df=1, $P = 0.029$), but rank was not related to fT levels (Chisq=0.928, Df=1, $P = 0.335$). Our findings suggest that different social organizations and mating systems in these baboons have created differential selection pressures on male aggressiveness that may be regulated by differential testosterone patterns.

63. VETERINARY CARE OF CHIMPANZEES (*PAN TROGLODYTES*) AT THE SAVE THE CHIMPS SANCTUARY

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The history of chimpanzee sanctuaries in the United States is much shorter than other types of institutions such as zoos and laboratories and subsequently, much less is known about the scope of veterinary care provided to these growing populations. Here, we present a broad overview of the veterinary program at Save the Chimps (STC) sanctuary and home to 255 chimpanzees. The veterinary care at STC addresses disease control and prevention, parasite management, reproductive issues, and the diagnoses and treatment of acute and chronic conditions. Save the Chimps, Inc. began with 21 retired air force chimpanzees and the colony of 266 chimpanzees held at The Coulston Foundation in New Mexico. For the first 2 years, STC used consulting veterinarians until a permanent veterinarian was hired in 2003. The veterinary program has evolved with the growth of the sanctuary itself: beginning with addressing the chimpanzees' medical and psychological conditions in their original housing in New Mexico, to the implementation of programs for the newly-formed groups of approximately 25 males and females of different ages at the new indoor/outdoor facility in Florida. The changes in veterinary care over the last 11 years are in response to a growing geriatric population, maturation of juvenile males and subsequent changes in social hierarchy and reflect the growth of high-quality veterinary care in accredited sanctuary settings.

64. CAPTIVE FEMALE BONOBOS (*PAN PANISCUS*) TEND TO BE MORE SOCIAL DURING TOOL USE THAN MALES

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Tool use occurs in several non-human species, including primates. Within the genus *Pan*, chimpanzees (*P. troglodytes*) exhibit tool use in both the wild and in captivity. Tool use in bonobos (*P. paniscus*) has been documented in captivity and suggested to occur in the wild. Recent comparative studies on chimpanzees and gorillas propose that social tolerance may facilitate the acquisition of tool use behavior in great apes. We previously reported that captive bonobos use tools in smaller social groups than gorillas and chimpanzees suggesting that number of neighbors do not play an integral role in tool use acquisition in bonobos. Here we investigate sex and age differences in these small social groups. Subjects were 16 bonobos housed at the Columbus Zoo and Aquarium where an artificial termite mound was placed in their outdoor exhibit and baited on a daily basis. All-occurrences of tool use at the mound and individuals present were video-taped and coded later where party size and composition were determined for each fishing bout. Females fished in larger groups (avg.=1.8 individuals) than males (avg.=1.3 individuals) (n=9, F=4.38, p<0.05). While there was no difference between adult and subadult males, adult females fished in significantly larger groups than subadult females (n=5, F=26.03, p < 0.0001). These results support previous knowledge of bonobo sociality where females are more socially cohesive and males tend to be more solitary.

65. STRATEGIES FOR SUCCESSFULLY SOCIAL HOUSING INCOMPATIBLE CYNOMOLGUS MACAQUE TRIADS

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At Charles River, we are committed to ensuring all animals have the highest level of care and welfare. At our facility, the typical study design requires primates to be housed in groups of 3 (or triads). While we have a near 100% socialization success with the majority of our cynomolgus macaques (*Macaca fascicularis*), aggressive behavior can occur within the triads, leaving 1 or more animals singly housed. If the social unit breaks down mid-study, regrouping is rarely possible due to study design constraints. We adopted a round-robin system within the triad to facilitate continued social housing and minimize single housing. This social housing schedule has been successfully implemented in all of the triads in which it has been attempted (n= 5 triads). The behavior staff identifies the animal who is most compatible with the other animals in the triad, typically the dominant or submissive, and that animal spends 3 – 4 days fully socially housed with one partner and then switches partners. Meanwhile, the less compatible partners remain at grooming access on days when they are not fully socialized. We have found this minimizes aggression and injuries within the triad and leads to greater social success. Overall, this system eliminated the need for a singly housed animal to have a behavioral exemption due to incompatibility, and has improved welfare for many animals in our facility.

66. A C-TO-T SNP IN THE PROMOTER REGION OF THE RHESUS MACAQUE (*MACACA MULATTA*) CRH GENE INTERACTS WITH EARLY REARING EXPERIENCES INFLUENCING ANXIOUS BEHAVIOR

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Studies show that dysregulation of HPA axis activity is related to various anxiety disorders. Recent research indicates that a single nucleotide polymorphism (SNP) in the promoter region of the rhesus macaque CRH gene, CRH-248 C>T, interacts with adverse rearing conditions, leading to dysregulation of the HPA axis. We proposed investigating this SNP and its influence on anxious behavior using 209 infant rhesus monkeys, heterozygous (C/T) for the CRH-248 SNP or homozygous for the wild type (C/C). Infants were raised for the first six months of life either with their mothers in species normative social groups (mother-reared – MR) or without adults in peer-only rearing groups (peer-reared – PR). At six months of age, subjects' stress reactivity was measured using a separation paradigm. Infants were isolated for 4, four-day separations, and durations of anxious behaviors were recorded during daily 5-minute observations. Repeated measures ANOVAs found significant rearing (p<.000), genotype (p=.003), and rearing-by-genotype (p=.003) effects on self-directed behavior, and separation-by-rearing (p<.000), separation-by-genotype (p=.001), and separation-by-rearing-by-genotype (p<.000) effects on stereotypic behavior. MR animals exhibited essentially no self-directed behaviors and very little stereotypic behavior. PR animals exhibited significantly higher levels of both behaviors with PR C/C animals exhibiting the highest levels of self-directed behavior and PR C/T animals exhibiting the highest levels of stereotypic behavior, suggesting that a gene-by-environment interaction in the CRH system modulates pathological anxiety.

67. JAVAN GIBBONS (*HYLOBATES MOLOCH*) VARY GESTURE USE BY RECIPIENT'S ATTENTIONAL STATE AT THE GIBBON CONSERVATION CENTER, CA

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Gestural communication of large-bodied apes has been extensively studied, however data on small-bodied ape communication is less common. We explored gestures used in communication by captive Javan gibbons (*Hylobates moloch*) housed at the Gibbon Conservation Center (Santa Clarita, CA). We hypothesized that a sender gibbon's gesture modality would vary with the recipient gibbon's attentional state. We predicted that senders would be equally likely to use all gesture modalities (tactile, visual, actions, and facial expressions) when the recipient was attending (facing the sender) but would be biased toward tactile gestures and actions when the recipient was non-attending (oriented away from the sender). We collected data from three gibbon groups (N = 10 individuals) using all-occurrences sampling and an ethogram to score behaviors from digital video recordings. Occurrences of gestures through the four modalities were recorded during a gibbon's attempt to interact with another group member. We observed 1,143 interactions over 20 days. When all data were aggregated, gibbons used visual gestures ($t_{18}=2.79$, $p=0.01$) and facial expressions ($t_{18}=2.60$, $p=0.02$) significantly more when the recipient was attending and tactile gestures ($t_{17}=2.47$, $p=0.02$) significantly more when the recipient was non-attending. There was no significant difference in the actions modality ($t_{18}=0.82$, $p=0.43$). These data show that Javan gibbons used gestures that are appropriate to the recipient's attentional state in three out of the four modalities.

68. DEVELOPMENT OF NON-INVASIVE GENETIC STUDIES OF THE BONOBOS (*PAN PANISCUS*) AT THE IYEMA FIELD SITE OF THE LOMAKO FOREST, DRC

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Studies of wild apes are critical to understanding the behavior of early humans. Chimpanzees and bonobos are good models as they are our closest relatives and equally related to humans. However, relatively few studies on wild bonobo populations have been conducted, and even fewer have used genetics to inform behavioral observations. We seek to use genetic data to aid in studies of behavior and demography at the Iyema field site in the Lomako Forest, DRC. The objective of this study was to assess the feasibility of microsatellite genotyping in non-invasively collected samples from our study location. 58 fecal samples were collected from this community, stored in RNA later, and used for DNA extraction. Endogenous DNA was quantified using a qPCR assay, with DNA yields ranging from less than 0.01 to 0.45 ng/ul and 39/58 samples containing sufficient amounts of DNA for microsatellite genotyping. Fifteen microsatellite loci were tested for amplification success and screened for polymorphism in a subset of the samples, with all loci successfully amplifying and twelve demonstrating polymorphism. Based on these results, we are completing the genotypes in our sample, re-extracting samples with low DNA yields, and continuing collection and analysis of genetic data from these bonobos for inference of party composition and relatedness among individuals. The importance of these genetic data to our ongoing study of wild bonobos is discussed.

69. APPLYING MEASUREMENTS OF ENERGY EXPENDITURE TO CAPTIVE APE WELFARE

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Energy use varies greatly between species. Much of this variation is related to body mass; larger animals generally require more energy than smaller animals. Apes, however, expend about half the energy expected for placental mammals of their size. Little is known of the factors influencing this remarkably low rate of energy use and how energy expenditure differs between and within ape species. To measure variation in total daily energy expenditure (TEE), we used a multidisciplinary approach that included behavioral observations and an innovative measure of metabolic energy use, the doubly-labeled water method. We sampled 51 subjects from the five ape taxa at eleven institutions, using this noninvasive method, which is easily applied in a zoo setting through positive reinforcement training. We found orangutans had lower TEE for their body size than African apes ($p=0.005$). Also, physical activity positively correlated with TEE ($p=0.01$), an effect which was strongest among apes with low to moderate activity levels. The resulting metabolic data holds important welfare implications, as it can be used to calculate caloric needs, activity patterns and body composition for each subject, and can be applied to the management of diets and activity programs. In addition to providing a reference for planning individual-specific care, these data will also contribute to understanding metabolism as it relates to common health problems in captive apes, including obesity and heart disease.

70. BEHAVIORAL INHIBITION CHARACTERIZED IN INFANCY PREDICTS SOCIABILITY IN ADULT RHESUS MONKEYS (*MACACA MULATTA*)

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In children, behavioral inhibition (BI) is characterized by a disposition to withdraw in the presence of strangers and novel situations. Research with humans has shown that, later in life, BI can result in a decrease in social behavior compared to control animals. To understand the continuity of BI into adulthood in rhesus monkeys, BI was characterized during infancy as low emotionality and activity, then $n=59$ adult rhesus monkeys (mean age=6.98, 38-females) were observed in naturalistic outdoor field corrals at the California National Primate Research Center by collecting eight 10-minute focal observations on time-ruled, 15-sec interval check sheets using instantaneous sampling method. A basic ethogram was used consisting of two behaviors: social (which included proximity, grooming, and contact) and non-social. At the end of observations, a Generalized Affectivity and Sociability Scale was used to index the extent to which subjects engage socially and non-socially (social-scale) in positive and negative (valence-scale) behaviors. In the outdoor corrals, adults classified as behaviorally-inhibited during infancy spent more time alone as adults compared to non-inhibited animals ($F(1,58)=8.179$, $p=.006$, $r^2=.125$) and were rated lower on the social scale ($F(1,58)=6.33$, $p=.015$, $r^2=.010$), while groups did not differ on valence of social behaviors ($F(1,58)=.105$, $p=.747$). Overall our data show that, as in humans,

individuals characterized as behaviorally-inhibited as infants showed lower levels of social interaction, but not differences in valence of behaviors in adulthood.

71. FEMALE-FEMALE BRIDGING BEHAVIOR IN TIBETAN MACAQUES (*MACACA THIBETANA*) AT MT. HUANGSHAN, CHINA

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Bridging is an affiliative interaction in which two individuals lift an infant or juvenile between each other. Male-male bridging has been studied in several macaque (*Macaca*) species, but female-female bridging has received less focus. Bridging between males is believed to act as an agonistic buffer, but it may function differently for females. We studied female-female bridging in provisioned Tibetan macaques (*M. thibetana*) from August-September 2014. We predicted that female-female bridges would show distinct patterns when compared to what has been reported for males. We recorded bridging behavior (n=119, 76 successful, 43 unsuccessful) from an ethogram using all-occurrences and focal-animal sampling of 8 adult and 4 subadult females. Rank was positively correlated with bridge initiations for females (Spearman's rank correlation; $r_s=0.75$, $n=12$, $p<0.05$), but in contrast to what has been reported for males, within bridging dyads, initiators were not more likely to be subordinate to recipients (Wilcoxon signed rank; $z=0.53$, $n=21$, $p>0.05$). Initiators utilized infants as the bridge more often than juveniles (Wilcoxon signed rank; $W=33$, $n=9$, $W(p<0.05)=29$), but bridges were equally likely to succeed with either (chi square test; $X^2=0.93$, $df=1$, $p>0.05$). Mothers more often received bridges utilizing their own offspring (Wilcoxon signed rank; $W=21$, $n=6$, $W(p<0.05)=17$). Our data suggest that female-female bridging in this study group is not consistent with the trends reported in male-male bridging. Supported by NSFC (30970414, 31172106) and NSF-OISE (1065589).

72. AGE AND SEX DIFFERENCES IN AGGRESSIVE BEHAVIORS OF WILD AZARA'S OWL MONKEY (*AOTUS AZARAE*) IN FORMOSA, ARGENTINA

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Azara's owl monkeys (*Aotus azarae*) are monogamous primates, with usually one adult male, one adult female and 1-3 young per group. To examine the role that aggression (e.g. biting, chasing, displacing) may play in group maintenance and dispersal, we collected 20-minute focal behavioral samples from 129 individuals in 15 groups in Formosa, Argentina, between 2001 and 2014 (6580 samples; ~2190 hours). Using frequency of aggression we examined whether the role an individual played in aggressive events (actor vs. recipient) varied with age and sex. Eight percent of focal samples (509 in 14 groups) contained aggressive behaviors. Preliminary analysis (1 group, 1262 focal samples) showed that all adults were more frequently actors ($n=8$, mean $76\% \pm 14\%$) than recipients, whereas all subadults ($n=5$, 24-48 months) and most juveniles (4/5, 6-24 months) were more frequently recipients (subadults: $94\% \pm 8\%$; juvenile: $64\% \pm 27\%$; Wilcoxon sign-rank test between subadults and juveniles: $W=23.5$, $p=0.027$). Adults of both sexes showed similar levels of aggression towards the young (males: 89%, females: 88%), consistent with the general lack of sex differences characteristic of these sexually monomorphic primates. However,

in 28 recorded conflicts between pair mates, males were more frequently actors (68%). Complete analysis of all groups will allow us to further evaluate how age, sex and other factors are related to aggression in owl monkeys. NSF BCS6400621020, BCS837921, BCS904867, BCS924352.

73. COOPERATING TO COMPETE: EVALUATING BEHAVIORAL COORDINATION IN RESPONSE TO SIMULATED TERRITORIAL INTRUSION IN CHIMPANZEES (*PAN TROGLODYTES*)

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We investigated cooperative behavior by simulating territorial intrusions with the playback of unfamiliar panthoots. We presented four groups of chimpanzees at Chimfunshi in Zambia with unique, unfamiliar panthoots on three test days. Behavior was recorded live and from camera traps located between the group start and the hidden speaker 50 to 120 meters away. Comparing behavior between interspersed control trials (familiar panthoots from neighboring groups) and test trials indicated that chimpanzees interpreted the playback as a threat (paired t-test N=4 groups, count of individuals who stand bipedally: $p < 0.001$; touch conspecific: $p = 0.051$; approach speaker: $p = 0.011$). Therefore, we questioned if and how chimpanzees coordinated their response with group members, and whether chimpanzees preferentially coordinated with bond partners (quantified by proximity and grooming for the preceding year). Chimpanzees appeared to spatially and temporally coordinate their approach toward the speaker by pausing, visually monitoring, and physically contacting group mates. Chimpanzees preferentially looked at and made physical contact with conspecifics with whom they shared a higher than average social bond (binomial test, look: $N = 14$, $p < 0.001$; contact: $N = 22$, $p = 0.006$). This approach moves beyond the classic experimental paradigm of dyadic coordination to obtain food, and demonstrates the cooperative capacity of chimpanzees in a natural, competitive group context.

74. SNOW MONKEYS SETTLE IN: THE DESIGN OF A NEW ZOO-BASED RESEARCH PROGRAM FOR JAPANESE MACAQUES (*MACACA FUSCATA*)

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Accredited zoos make important contributions to primatology by supporting efforts in the field and designing exhibits that enable research locally. At the Lincoln Park Zoo in Chicago, we have recently opened the Regenstein Macaque Forest, a 7,300 sq ft exhibit for Japanese macaques (*Macaca fuscata*). The exhibit was designed to mimic the macaques' natural habitat in the coastal forests of Japan and provide innovative research opportunities including remote behavioral monitoring and voluntary access to dual touchscreen booths. Much of this research is visible to the public and interpreted by trained educators. We will discuss how the exhibit design enables data collection efforts, which, in turn, allow us to closely monitor how the monkeys adapt to their new home and respond to the presence of visitors. We will present data on space use and social proximity to describe the monkeys' early use of the exhibit and the development of this newly-formed group's social network. By communicating about the efficacy of the novel design features

and the initial response of the macaques to this exhibit, we hope to provide valuable information to primatologists who are planning research in zoos and other non-traditional settings.

75. MORE MONKEYS THAN PEOPLE? POPULATION SIZE AND ECOLOGICAL FLEXIBILITY IN ST. KITTS VERVET MONKEYS (*CHLOROCEBUS AETHIOPS SABAEUS*)

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African green vervet monkeys have thrived in St. Kitts since the mid-1600s. Today, vervets occupy at least four distinct habitats: the dry scrubland of the southeast peninsula, residential areas, agricultural areas, and the rainforest interior. This systematic estimate of the St. Kitts vervet population aims to establish the range size (using GPS/GSM tracking devices) and group size (using visual observations from hides) of at least two troops living in each habitat. Thus far, we have tracked two adult males from two troops on the southeast peninsula for three months and observed their respective troops for approximately 20 hours each. The average range size of these troops is 59.7ha and the average group size is 50 individuals. Assuming that: 1) these results are consistent for all troops in St. Kitts, 2) vervets inhabit the entire island, and 3) there is no overlap between troop territories, these results indicate a potential island-wide population of up to 18,000 individuals. This is a low estimate, as troops in the other habitats are likely to have much smaller ranges. St. Kitts is 68 km², and has long been a resource-strapped island. This level of vervet resourcefulness and ecological flexibility is an exciting and rare opportunity to study primate adaptability. The growing vervet population is an issue of genuine concern among Kittitians that demands innovative ethnoprimateological methods and analyses to resolve.

76. POLYMORPHIC MICROSATELLITES IN THE 5' FLANKING REGION OF VASOPRESSIN RECEPTOR GENE 1A (AVPR1A) IMPACT SOCIABILITY IN CAPTIVE CHIMPANZEES (*PAN TROGLODYTES*)

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Chimpanzees are the only apes that are polymorphic for a deletion of an ~350bp microsatellite region (DupB) in the 5' flanking region of AVPR1a. This results in two genotypes, one with a long allele (the ancestral genotype) and another with a shorter allele. Variations in the length of microsatellites 5' of AVPR1a have been associated with the prevalence of certain social behaviors (pair-bonding, paternal care, degree of social interest) along with differential levels of expression of AVPR1a in the brains of voles. In this study we hypothesized that, chimpanzees lacking the DupB microsatellite will spend more time alone (in the absence of conspecific social partners)

compared to chimpanzees that retain the ancestral “long allele” genotype. Approximately 332 hours of observational data (10 minute focal follows, 1-minute instantaneous sampling interval) were collected from 70 chimpanzees housed at the Yerkes National Primate Research Center (22 chimpanzees) and the Michale E. Keeling Center for Comparative Medicine and Research (48 chimpanzees). Chimpanzees were considered to be alone if no conspecifics were within ~1.5 meters of the focal subject. There was a significant difference in the percentage of time spent alone between the chimpanzees with long (49.1) or short alleles (57.5), $F_{(1,66)}=5.612$, $p=0.021$. These results indicate that chimpanzees with a deletion of the DupB microsatellite 5’ of AVPR1a may be less social than chimpanzees that retain the ancestral genotype.

77. USING A TOOL: IMPACT OF DEGREES OF FREEDOM ON TERMINAL PERFORMANCE BY TUFTED CAPUCHIN MONKEYS (*SAPAJUS* SPP.)

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Humans discover the affordances of objects through action and control multiple degrees of freedom when using a tool. We examined if capuchin monkeys ($N = 4$) displayed these characteristics while using a hoe tool to retrieve a token. The handle of the tool was variously configured as a single rigid segment, two segments with one planar joint, or three segments with two (orthogonal) planar joints. From video playback, we coded the movements of the tool and actions on the handle for a subset of 20 trials (out of 40) per condition in the final phase of testing, following more than 100 trials of practice with each condition of the handle. Three monkeys retrieved the token effectively (median= 5.5 actions/trial, pooled conditions). These monkeys used the rigid tool conventionally but allowed the head of the tool to rest horizontally in 83% of trials in the jointed conditions. The fourth monkey maintained less control of the tool and token in all conditions (median= 9 actions/trial) and didn’t use the tool differently across conditions. Unlike humans, the monkeys’ mastery of this task reflected accommodation of action to the features of the tool rather than active control of the degrees of freedom of the handle. Future analyses will consider behavior accompanying practice with the tool from initial presentation to mastery. Supported by NIH – HD060563.

78. USING A PREDICTIVE GROWTH MODEL TO INFORM MANAGEMENT STRATEGIES OF A CAPTIVE PRIMATE COLONY

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Managing a breeding colony of rhesus macaques (*Macaca mulatta*) for biomedical research requires balancing animal production with use; the colony must supply sufficient animals to support institutional research needs, maintain enough breeding animals to remain self-sustainable, and yet must not grow at a rate that exceeds available housing space. To improve our ability to make informed colony management choices we developed a stochastic, discrete-time, and age-structured model of colony growth. The model was constructed in Mathematica using basic linear algebra, in which numeric vectors and matrices represent populations and their corresponding age-structured properties, such as fecundity, mortality, and “migratory” effects of harvest and import. Natural variation was modeled using a Monte-Carlo simulation. The goals of this model were to predict breeding colony growth in upcoming years, determine the availability of male and female

monkeys of various ages for upcoming research projects, and determine the effect of various scenarios (e.g., collapse of a breeding group, increased demand of a specific age class for research) on breeding colony sustainability. In order to accurately predict colony growth, model parameters were determined using seven years of retrospective data on animal fecundity, death rates, group formation rates, and harvest rates. We demonstrate how the resulting model can predict detailed colony demographics under multiple theoretical scenarios, and, most importantly, inform management choices in order to maintain an ideal colony size.

79. AGGRESSION IN A BACHELOR GROUP OF GORILLAS

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An overabundance of male gorillas in zoos has led to a push to house male gorillas in “bachelor” groups, a state rare in the wild. Researchers are concerned that these housing conditions may lead to high aggression, particularly while establishing dominance hierarchies, and may result in unstable long-term relationships. As a result of the genetic importance of these males, a viable, yet safe, housing option is essential for the long-term survival of the species. This project observed an established group of three male Western Lowland Gorillas (*Gorilla gorilla gorilla*) at the Como Park Zoo in St. Paul, MN. We examined behavior from 94.7 hours of data, collected March-August 2014. A total of 237 aggressive encounters were observed. The majority, 60.3% of these encounters involved displacement events or displays. Only 13.9% of encounters included hitting or biting, with the remainder comprising directed pursuits. Given the vast difference between indoor and outdoor conditions, we also compared aggression and activity budgets between these two locations. Randomization tests found no differences between locations for aggression rate ($p = .950$), or any of the aggression categories ($p > .05$). The bachelor group at the Como Zoo is relatively stable and non-aggressive. However, the three males included in this group are relatives (half-brothers and cousin). Future research should explore whether or not relatedness of individuals impacts relationship stability.

80. EFFECT OF SUNLIGHT EXPOSURE ON HAIR LOSS IN CAPTIVE RHESUS MACAQUES (*MACACA MULATTA*)

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Alopecia is a ubiquitous, multifaceted problem at facilities caring for captive rhesus macaques. Stress, bacterial infections, compromised immunologic function and nutritional deficiencies have been considered as potential etiologies for this condition. We examined the effect of direct sunlight exposure on alopecia in adult, group housed rhesus macaques. Subjects (62F, 11M) lived in one of 7 enclosures containing 20-45 individuals. Four enclosures were southern facing (i.e., had relatively high sunlight exposure) and three were northern facing. Animals were given an alopecia score from 0-5 based on hair loss during semi-annual physical exams. We also took a hair sample to measure cortisol. We used GLMMs to evaluate alopecia scores, with social group as a random effect. Fixed effect variables tested included sex, age, group density, hair cortisol concentration, and exposure of the enclosure. Sunlight exposure significantly predicted alopecia.

Animals in northern-facing enclosures had significantly more alopecia than those in southern-facing enclosures ($B=0.68$, $p<0.05$), suggesting that sunlight exposure might influence hair loss. Interestingly, there was no correlation between hair cortisol concentrations and alopecia score ($r=0.14$, $p=0.21$), suggesting that animals with high levels of alopecia were not suffering from more chronic stress than with little hair loss. More work is needed to determine whether the decreased sunlight exposure results in decreased levels of Vitamin D, which has been associated with alopecia.

81. AN EVALUATION OF THE EFFICACY OF VIDEO CONTENT AS A FORM OF ENVIRONMENTAL ENRICHMENT IN RHESUS MACAQUES (*MACACA MULATTA*)

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Video content is often provided as a form of sensory enrichment for laboratory nonhuman primates (NHP). A number of studies report that NHPs engage with video; however, few studies measure video interaction unobtrusively. The goal of this study was to assess the extent to which NHPs engage with videos and whether content will affect interest. Nineteen mixed sex (male, $n=12$; female, $n=7$) rhesus macaques (*Macaca mulatta*) (old, $n=10$; young, $n=9$) participated in this study. The facility enrichment plan requires that animals receive video for 1 hour weekly. Participants were familiar with the video delivery procedure. We equipped the television with two webcams directed towards the target animals. Two forms of video were presented: cartoons and footage of pen-housed conspecifics. Each type was presented for 5 trials. Snapshots of each subject were taken every two minutes. Each 2 min frame was scored for looking behavior, defined as the subject's eyes visible and directed toward the television. For standard content, we found the animals spent 25% (15.1 min.) of the total time watching. Conspecific content increased looking to 34% (20.5 min.). Younger animals viewed the television more than older animals. Older animals time spent looking did not change with content (23.4% vs. 21.1%). However, older single housed monkeys spent less time looking when compared to paired monkeys irrespective of content [Standard content: $F(1,18)=13.11$, $p<0.01$; Conspecific content: $F(1,18)=30.1$, $p<0.001$].

82. WITHIN-GROUP SPATIAL POSITION AND SWATH GEOMETRY OF BEARDED CAPUCHIN MONKEYS (*SAPAJUS LIBIDINOSUS*)

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The location of animals in space in relation to one another is a fundamental feature of social organization. At the group level, social relationships may be indicated by group density, within-group spatial position and swath geometry. At the level of individuals, social networks and affiliative relationships are derived from repeated measures of spatial proximity. We evaluated a novel method for collecting spatial locations of members of one group of capuchin monkeys using GPS-enabled tablets. For each recording, four researchers scanned the group for a maximum of 8 minutes, locating individuals visually within the image. Separately, we evaluated the accuracy of the GPS sensors and the accuracy of the humans in marking particular points. We conducted a total of 199 scans and observed 70.4% of the group on average ($sd = 3.4$ individuals). The group's average swath size was 1046.8 m², with a mean buffer around each monkey of 65.7 m². As a

whole, males had a mean inter-individual distance from other males of 23.9 m. Male-female inter-individual distance was of 22.8 m and female-female was 20.8 m. The shape of the group swath was often a horizontal wedge in relation to the direction of travel. We evaluate the usefulness of this system for measuring spatial properties of the group over time, social relationships among individuals, and variability of spatial organization in relation to landscape characteristics.

83. MANY NEEDLES IN THE HAYSTACK: GETTING MORE FROM RECORD SYSTEMS AND COMPUTING TECHNOLOGY

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We demonstrate a flexible and easy-to-use system for mining large data resources to define and evaluate predictive models. Developed in Mathematica, the application allows users to target specific data resources, of virtually any kind, for statistical analysis and computation of fitted models. To refine and demonstrate it, we queried decades of data from our institutional record system, specifically filtering for brain weight in rhesus macaques. We sought to test reports that adult weights are stable in maturity, where our larger dataset, notably covering advanced age, would provide additional statistical power; we also endeavored to establish age of brain maturity. After filtering outliers and underrepresented animals (Chinese and Indian-Chinese hybrids), piecewise regression on our final sample of 2093 males and 2713 females revealed that weight increased rapidly in infants (0.1942 g/day males to 106 days, 0.3161 g/day females to 61 days), slowed in juveniles (0.0122 g/day males 106 to 1690 days, 0.0112 g/day females 61 to 1342 days), was stable in adult females (1342 days and older), yet declined significantly ($p < 0.05$) in adult males (-0.00043 g/day 1690 days and older.) Hence this application's ability to conveniently query large datasets indeed provided additional power to discern finer levels of sex-dependent change with age. Additional benefits include both flexibility to mine data across institutions and varied record systems, and portability to facilitate application sharing and collaborations.

84. PARALYMPIC PRIMATE: SKILLFUL NUT-CRACKING WITH ONE FOOT

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We aim to examine and compare the nut-cracking actions of a disabled wild capuchin monkey (*Sapajus libidinosus*) in Brazil before, immediately after, and up to three years following the disabling incident. We recorded 53 episodes (range 8-16 per year) for the subject over five consecutive field seasons and 42 episodes (range 5-10) for another adult male as a comparison. We coded actions and outcome in nut-cracking. In a subset of episodes (N=15), we conducted biomechanical analysis and examined movement patterns and temporal variations in the highest strikes per episode. Immediately after injury, the disabled individual's control of stone and balance of body drastically decreased. He also used his tail as support after injury. Efficiency and body weight was lowest one year after the injury but other behavioral measures of effective nut-cracking were starting to improve at one year and returned to pre-injury levels two to three years after the injury. Lifting height and velocity was significantly lower (ANOVA, $\alpha=0.05$) immediately following injury but was starting to approach pre-injury levels one year after the incident. The

subject also maintained the same kinematic strategies and his individual lifting/striking pattern even immediately after injury. Both behavioral and biomechanics data combine to reveal how a severe disability can be effectively accommodated by a highly skilled individual during strenuous percussive tool use. This case highlights behavioral adaptability in wild primates.

85. PREDICTING OWL MONKEY PAIRING SUCCESS FROM THE FIRST HOUR OF INTERACTION

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Owl monkeys (*Aotus sp*) are nocturnal primates native to South America. Typical social groups consist of monogamous pairs and their juveniles and/or infants, formed as juveniles of each sex emigrate from their natal groups. In the Owl Monkey Breeding and Research Resource, a long term breeding resource of owl monkeys, efforts are made to form pairs to avoid inbreeding and increase genetic diversity. Potential mates are placed in adjacent cages providing protected contact and each with its own nest box. After three days, the potential mates are given free access to both cages. We collected instantaneous scan data during the first hour of interactions from 50 pair formations. We analyzed percent of time animals were either vigilant, sleeping, eating, drinking, engaged in agonistic interactions, or nonsocial manipulation of objects in the cage between successful and unsuccessful pairs. Pairs that were ultimately successful spent significantly more time vigilant together [ANOVA, $p < 0.01$] and in proximity [ANOVA, $p < 0.01$] with one another. They also spent significantly more time in the same nest box [Chi Square, $p < 0.01$] than unsuccessful monkey pairs. The pairs did not show behavioral synchrony, defined as both owl monkeys engaged in the same behavior in the same scan. This study provides a guide for successfully pairing owl monkeys, and may stimulate field observers to develop hypotheses about what they may see during pair formations.

86. IMPACT OF NATURALISTIC VS ARTIFICIAL ENRICHMENT DEVICES ON VISITOR PERCEPTION OF A ZOO-HOUSED GROUP OF CHIMPANZEES (*PAN TROGLODYTES*)

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The trend in modern zoo exhibit design is to promote a naturalistic appearance in order to facilitate education about the wild counterparts of these animals and their environment, promote positive perceptions of the animals, and encourage species-typical behaviors. Though there is some evidence of the positive effects of naturalistic environments, less is known about how naturalistic enrichment within these environments might affect visitor perceptions. In this study, we provided a group of zoo-housed chimpanzees living in a naturalistic indoor-outdoor exhibit with several enrichment devices that varied in their degree of naturalism. While the enrichment was present in the exhibit, we surveyed zoo visitors ($n=150$) about their perceptions of the exhibit and the animals. We found that although visitors emphasized the importance of a naturalistic exhibit, their perception of the animal's emotional state or the environment's ability to replicate the animal's natural environment was not affected by the naturalism of the enrichment present in the exhibit at the time of the survey ($F(36,367)=0.931$, $p=0.586$). Though naturalistic

environments have been shown to have positive outcomes for animal behavior and visitor attitudes, these findings indicate that non-naturalistic enrichment seems to have negligible effect on how zoo visitors perceive these environments or the animals inhabiting them. As a result, managers may have greater flexibility when selecting enrichment options without the restrictions of having them appear natural.

87. MANAGEMENT STRATEGIES FOR ABANDONED RHESUS MONKEY INFANTS (*MACACA MULATTA*) IN AN SPF BREEDING COLONY PART 1: FOSTERING

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In 2014, 397 infants were born at the YNPRC Field Station SPF rhesus colony. 9% (n=34) were abandoned and eligible for fostering (if reuniting with dam failed). There are five candidate foster mothers: 1) Females that have recently given birth, 2) Females that have had a recent stillbirth or lost an infant, 3) Females with a foster history, 4) Females that accept infants in a compound, and 5) Females who accept infants in caging. Of the 34 abandoned infants, 12% were reunited with dam, 41% were fostered, 36% were orphaned and raised in the nursery, and 12% died. 12 females fostered infants; 2 took 2 infants, 8 took a foster in addition to their own infant, while 2 females fostered a single infant each. The conditions of the dams included: recent birth (n=9), lactating from the previous year's infant (n=2) or death of an older infant (n=1). 43% of the pairings were accomplished in caging, with 57% occurring in the compound. 36% of the dams had a fostering history. There was a significant relationship between date born and foster success; animals born earlier in the birth season (when there were the highest numbers of birth) were more likely to be fostered than animals born later (Spearman's Rho 0.503, $p < 0.003$) This suggests that the availability of females that had recently given birth increased foster success rates.

88. TESTOSTERONE AND BEHAVIORAL RESPONSE TO INTRUDERS IN CAPTIVE COMMON MARMOSETS

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Marmosets are unusual in that they invest in mating effort while providing parental care. Males rely on testosterone to shift their behavioral focus between mating competition and paternal care, yet little is known about how the competing demands of mating and parenting are mediated in females. Given the importance of shifting energetic priorities from mating to parenting, testosterone may also mediate this trade-off in females. We compare male and female behavioral and hormonal response to intruders. We hypothesize that both sexes will react aggressively toward intruders, have similar testosterone levels, and that testosterone will correlate with aggressive and sexual behaviors. Fecal samples were collected from six breeding pairs of marmosets and assayed for testosterone using EIA. Behavior during intruder tests was videotaped and scored using continuous data collection. We found no significant difference between male and female rates of

aggression directed at intruders ($t = 1.78$, $p = 0.11$). Baseline testosterone levels were similar between males and females ($t = 0.93$, $p = 0.39$). Test day hormone samples positively correlated with the percent time spent displaying aggressive behavior toward the intruder group (Spearman's $r = 0.583$, $p = 0.05$, one-tailed). Our results show that female marmosets engage in mating competition at similar levels to males and exhibit reduced hormonal dimorphism, suggesting that females respond to evolutionary pressures in a similar manner as males.

89. REMOTE SAMPLING OF HAIR FOR DNA FROM CANOPY DWELLING PRIMATES: A STUDY WITH RED RUFFED LEMURS, *VARECIA RUBRA*, IN MASOALA NATIONAL PARK, MADAGASCAR

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Threatened by habitat loss, forest fragmentation, and hunting, *Varecia rubra* face the risk of extinction in our lifetime. Collection and analysis of DNA can provide insight into the structure of existing populations, but because *V. rubra* spend most of their time in the canopy above 15 m, DNA collection is logistically challenging. We developed an affordable, robust hair trap to collect samples for DNA that eliminated handling the lemurs and prevented contamination and the sampling of multiple individuals. The hair traps were first tested in captivity, resulting in collection of samples sufficient for DNA analysis from 4 of 5 *V. rubra*. Failure to collect hair samples during preliminary trials at Masoala National Park (MNP) during September 2013 resulted in changing the bait to a fruit/salt mixture. Subsequently, six hair traps were installed in the MNP for nine consecutive days during October 2014. All traps were installed between 16-20 m in the canopy in areas where *V. rubra* were frequently sighted. During second trials, hair samples were successfully collected from 20% of the traps. All successful hair traps included salt in the bait, were checked every other day rather than daily, and were installed in fruit bearing trees. Based on hair morphology, samples were probably from sympatric *Eulemur albifrons* rather than *V. rubra*. Future efforts will focus on improving collection from the target species.

90. ESTIMATING OCCUPANCY AND DETECTION PROBABILITY OF *CALLICEBUS NIGRIFRONS* AND *CALLITHRIX AURITA* FROM CALL SURVEYS IN A LARGE ATLANTIC FOREST REMNANT

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Large forest remnants are key sources to maintain biodiversity, particularly for the conservation of primates within small fragments. Thus, we evaluated the primate population of a large Atlantic Forest remnant (35,000 ha) in Brazil, estimating the occupancy and detection probability of black-fronted titi monkeys (*Callicebus nigrifrons*) and buffy-tufted-ear marmosets (*Callithrix aurita*). We performed 270 call surveys [three in each season (dry and wet) at each site (N=45)] using playback method. Simple multi-season occupancy models were used to investigate how area protection status, elevation, vegetation cover and hydrography influence the occupancy of each species. We also accounted the influence of time of day, season, temperature, precipitation and

monthly fruit availability on their detection probability. The occupancy of titi monkeys and marmosets in the remnant was high ($\psi=0.97\pm 0.05$; $\psi=0.63\pm 0.20$, respectively). Although the analyzed environmental covariates had similar and low relevance in general for both species (since their models did not differ substantially from the null models), we had some evidence that protection status (upper-case-sigmaAICw=0.52), hydrography (upper-case-sigmaAICw=0.49) and high quality vegetation (upper-case-sigmaAICw=0.38) positively influence the occupancy of marmosets. For the detection probability, temperature had a large positive effect for both species (titi monkeys: upper-case-sigmaAICw=0.93; marmosets: sigmaAICw=0.50), emphasizing the importance of accounting for this variable in ecological and behavioral studies. Supported by: FAPESP, CAPES, FAEPEX, IdeaWild.

91. INDIVIDUAL DIFFERENCES IN HAND PREFERENCE DURING A NOVEL TASK IN COMMON MARMOSETS (*CALLITHRIX JACCHUS*)

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In most studies of hand preferences, subjects are tested or observed over many trials and the strength of preference is reported in terms of the relative number of times each hand was used (Handedness Index = $R-L/R+L$). This approach masks potentially interesting data insofar as we do not pursue an explanation for circumstances in which the non-preferred hand is used. We hypothesized that initial exposures to a novel task might evoke a variety of cognitive and emotional states that engage competing hemispheric specializations, leading to ambilateral hand use. We recorded all-occurrences of hand use in seven common marmosets during ten exposures to a task that required subjects to use one hand to reach inside a tube to obtain food. Three subjects were ambilateral in the initial exposures to the task (HI scores between -0.33 and 0.04), but became strongly lateralized by the fifth exposure (HI scores > 0.54). Three other subjects preferred one hand from the start (HI scores > 0.88). The seventh marmoset exhibited ambilaterality throughout all ten exposures. Except for the seventh marmoset, HI scores previously calculated from 300 instances of spontaneous hand use in everyday situations did not predict how lateralized a marmoset would be in the early exposures to the novel task. Careful examination of variability within individuals' patterns of hand use may give us additional insight into hemispheric specialization.

92. LABORATORY HOUSED RHESUS MACAQUES (*MACACA MULATTA*) WITH SELF INJURIOUS BEHAVIOR SHOW A BLUNTED BEHAVIORAL RESPONSE TO THE HUMAN INTRUDER TEST

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Self-injurious behavior (SIB) occurs in some monkeys but it is unclear whether this pattern is associated with affective disorders (e.g., anxiety or depression). Our objective was to examine the

relationship between anxiety and SIB in macaques using a well-established measure of anxiety, the human intruder test (HIT). A cage-side variant was run on 77 macaques, 41 with a record of SIB. The HIT consisted of four 2-minute phases, baseline, profile, stare, and away (back turned). We predicted that monkeys with SIB would demonstrate more anxiety on this test. Video tapes of the HIT were scored for duration and frequency by observers blind to the subjects' SIB status and analyzed by a mixed-ANOVA. In contrast to our prediction, SIB subjects spent significantly less time showing anxious behavior than controls ($p=0.046$); this effect was present during the profile and stare phases ($p=0.013$). SIB subjects showed significantly less aggressive behavior toward the intruder ($p=0.042$); this effect was present during the stare phase ($p=0.012$). SIB subjects showed the same range of behaviors as controls, but significantly less behavioral change overall ($p=0.038$) and more specifically during the stare phase ($p=0.009$). These data suggest that SIB is associated with a blunted response to the HIT with lowered affect during the stare phase. These results are inconsistent with anxiety but more consistent with a depressive like disorder. Supported by NIH Grant R24OD011180.

93. WORKING MEMORY IN *ATELES GEOFFROYI*: RESTING-STATE FMRI IN MEDIAL PREFRONTAL CORTEX

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Resting state functional images measured in absence of a task, aim at detecting low frequency fluctuations in the Blood Oxygen Level Dependent (BOLD) signals. Working memory involves the brain system that provides temporary storage and manipulation of the information necessary for complex cognitive tasks such as language comprehension, learning, and reasoning. Three healthy adult monkeys were used to acquire whole brain images (2 f, 1 m; $10.5 \pm SD 2.5$ years). All MRI studies were performed on a 3T scanner. To estimate functional connectivity, ICA was performed using GIFT and data was preprocessed. A group ICA was made with $Z > 3.39$ out of 20 components were considered noise and eliminated after visual analysis. The remaining components were projected onto the corresponding T1 anatomical images. ICA analysis showed clusters of connected brain regions in the frontal area, prefrontal cortex, dorsal anterior cingulate and superior parietal cortex in spider monkeys. Analysis presents two of those components: executive Control and working memory networks. These two components combined were similar to the component found by Damoiseaux, in healthy adult humans. The memory skills of *Ateles* are reported to exceed those of other primates. *Ateles* also display complex foraging strategies as well as large social groups. The components observed in spider monkeys might be a result of their arboreal life form in a highly dynamic environment such as the rainforest.

94. IS AMYLASE EXPRESSION BY THE HUMAN MAMMARY A GENUS *HOMO* SPECIFIC TRAIT?

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Human milk contains salivary amylase, a starch-digesting enzyme. In humans, the salivary amylase gene has undergone multiple gene duplication events, such that amylase concentration in saliva and milk is highly variable. European and US public health officials recommend combining feeding starchy supplementary foods (e.g. cereals) with a nursing bout, or even mixing breast milk with the cereal to aid digestion. Milk amylase may have been an important adaptation allowing human infants to be provided with starchy supplemental foods at an early age. Gorilla and orangutan infants are nursed by their mothers for 3-5 years; this overlaps time periods when the infant is eating foods that may contain starch. Is the high concentration of amylase in human milk an enhancement of an existing condition, or is milk amylase a unique adaptation of genus *Homo*? Human milks and milks from three gorillas (*Gorilla gorilla*) and three orangutans (*Pongo abelii* and *P. pygmaeus*) were assayed for amylase activity. Human milks showed high and variable amylase activity (46-91 units/min). Milk from orangutans and one of the gorillas showed no amylase activity; milk from the other two gorillas showed very low activity (1-2 units/min). Since other enzymes potentially in milk can digest starch, the next step is to measure amylase peptide in gorilla milks that exhibit activity. These data suggest that mammary expression of amylase may be human specific.

95. THE MANAGEMENT OF SELF-INJURIOUS BEHAVIOR IN A LABORATORY HOUSED RHESUS MACAQUE USING A MULTI-COMPONENT INTERVENTION PACKAGE AND PAROXETINE

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Primates in captivity sometimes develop stereopathies including self-injurious behavior (SIB). Interventions for SIB in primates are often implemented without understanding function of the behavior or what environmental variables influence its expression. In humans, applied behavior analysis is utilized to identify function and design successful function based interventions. This technology is beginning to show promise in non-humans as well. The participant in this case was a rhesus macaque (*Macaca mulatta*) with a history of self-biting and wounding. To identify function of his SIB, staff interviews, observations and a functional behavior assessment were conducted. SIB was hypothesized to be multiply maintained by social contingencies and automatic reinforcement. A multicomponent intervention which included environmental modifications, skills training and differential reinforcement decreased rates of self-biting, yet self-wounding persisted. Following a severe wounding event, treatment with paroxetine was implemented. Though self-biting continued to occur at a decreased rate, self-wounding was ameliorated following paroxetine treatment. The pharmacological approach provided an effective method to manage self-wounding which was likely maintained by automatic reinforcement while self-biting, likely maintained by social contingencies, continued to be reduced through behavioral techniques. Though we were able to hypothesize the maintaining reinforcers of SIB in this case, a functional analysis (FA), in which social variables are manipulated to identify function, could have pinpointed function more clearly. Modifying FA procedures to assess SIB in laboratory primates warrants further investigation.

96. COMPREHENSIVE STUDY OF COMMUNICATION IN CAPTIVE PAIRS OF AOTUS NANCYMAAE IN A SEMI-NATURALISTIC ENVIRONMENT

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Owl monkeys are the only nocturnal anthropoid and thus rely more on olfactory and vocal communication rather than vision. Detailed observations on olfactory and vocal communication are more easily studied in captivity but work in the field has helped us understand their functional value. The DuMond Conservancy houses owl monkeys in outdoor enclosures and they are exposed to changes in temperature, rainfall, and luminosity. Coupled with excellent observation conditions the advantages of studying owl monkey communication at the DuMond conservancy are without parallel. For several years we have been conducting a comprehensive study of owl monkeys' communication in twelve pairs of *Aotus nancymaae*. Under these semi-natural conditions we discovered high rates of olfactory communication (scent marking and urine drinking) at 13.5 per hour. Vocal communication (chucks, trills, hoots, and alarm calling) yielded rates of 6.7 per hour. Compared to both vocal and olfactory, visual communication (arching and lip-smacking) appeared to occur at a lower rate of 2.1 per hour. We believe the lower rates of visual communication in owl monkeys are accurate; however, we concede that the difficulties in observation in a semi-natural habitat and at night may have resulted in some underreporting of close range communication.

97. INTERACTIVE PROJECTION AS ENRICHMENT IN CAPTIVE RHESUS MACAQUES (*MACACA MULATTA*)

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Current inanimate enrichment techniques can be divided into two categories: active forms such as manipulanda, foraging devices, and swings; and passive forms like video and sound. This study assessed the use of an interactive projection apparatus to provide active stimulation through contact and passive stimulation through moving images. Thirteen adult rhesus macaques (three female), of which nine were individually housed, were given access to the apparatus during six 10 minute trials. Through video analysis we determined frequency and duration of contact with three categories of stimuli: treat on the projection, static area of projection, or moving projected element. Females spent more time contacting the apparatus than males ($p < 0.02$) and total time spent in contact increased across the first three trials, then decreased across the last three ($p < 0.02$). Individual use varied, and the results were stratified into three user categories: low-users (three males: < 50 contacts), medium-users (six males, one female: 250-100 contacts) and high-users (two females, one male: 350-850 contacts). The low-users and five medium-users focused primarily on treats; the remaining medium-users and the high-users engaged with active elements most often. These results suggest that for some macaques, interactive projection provides active stimulation; for others, it serves as a novel foraging situation. Additionally, the development of applications for mobile devices is a promising next step to increase accessibility of interactive enrichment.

98. EARLY PREDICTORS OF SOCIABILITY IN RHESUS MACAQUES (*MACACA MULATTA*)

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Rhesus monkeys show stable and pronounced individual differences in sociability, which reflect their motivation and competence to engage in social interactions with others. Low-sociable compared to high-sociable monkeys initiate and receive fewer affiliative interactions, spend less time in proximity and grooming with other animals, and display more inappropriate social behaviors, suggesting both lower motivation and poorer social skills. The goal of the present study was to examine whether individual differences in the early ability to process social information would be predictive of monkeys' social competence later in life. Two putative predictors – looking response to video playback of a conspecific displaying both aggressive and nonsocial behaviors, and a preferential looking task to assess visual recognition memory – were examined in a sample of 50 male rhesus macaques when subjects were 90–120 days of age. Logistic regression analysis [$\text{Chi}^2= 8.842$, $p= .012$, $R^2= .26$] revealed that infant subjects which showed a greater ability to discriminate among different social signals, and therefore to modulate their looking behavior accordingly, were later classified as high-sociable. Moreover, the enhanced ability to recognize a novel stimulus in infancy was associated with being later classified as high-sociable. Our findings suggest that an early capacity to process important social information may account for differences in monkey's motivation and competence to establish and maintain social interactions later in life.

99. ASSESSING POTENTIAL INDICATORS OF GROUP COHESION IN ZOO-HOUSED CHIMPANZEES (*PAN TROGLODYTES*)

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Little is known about what behavioral measures are best to generate consistent representations of captive chimpanzee social structure. Such information is useful for describing chimpanzee sociality, comparing groups across facilities, and facilitating animal management. As managers often have limited time to collect observational data, we sought to investigate the most efficient methods for describing chimpanzee group structure and whether different measures were comparable. We ran multiple social network analyses, using twice-weight association indices, from 12 months of observational data (826.5 hours from 2012 to 2013) of a stable chimpanzee group ($n=6$) housed at Lincoln Park Zoo. The four social behaviors analyzed were frequency of play, directional grooming, proximity (within 1m) and contact. Mantel tests were used to compare networks, with Bonferonni correction for multiple comparisons (adjusted $\alpha = 0.008$). This revealed significant correlations between the three matrices that did not involve play (directional grooming and proximity: $r= 0.711$, $p=0.004$; directional grooming and contact: $r=0.702$, $p=0.002$; proximity and contact: $r=0.839$, $p=0.001$). Thus, these behaviors (contact, proximity and grooming) may provide equivalent representations of group cohesion, whereas play is a potential indicator for a different construct, although additional analyses with more groups are required. We propose that institutions consider focusing limited resources on just one of the three measures in order to define a group's social network and better understand captive chimpanzee group cohesion.

100. MACAQUE SPECIES DIFFER IN SOCIOAFFECTIVE BEHAVIORAL RESPONSE TO A STANDARDIZED CHALLENGE (*MACACA FASCICULARIS*, *M. RADIATA*, *M. MULATTA*): POSSIBLE IMPLICATIONS FOR NEUROSCIENCE RESEARCH.

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The study examines socioaffective behavior in three closely-related macaque species. Field studies and a limited number of laboratory investigations have produced evidence of species differences in key aspects of affective behavior that are highly relevant to translational behavioral neuroscience. Direct experimental comparisons are lacking, however. We evaluated species differences in male cynomolgus, rhesus, and bonnet macaques' response to a well-validated assessment of anxiety-like behavior, the Human Intruder Paradigm (HIP) previously used only with rhesus monkeys (n=14, n=11, n=7, respectively). All three species exhibited behavioral evidence of differentiation between the baseline condition and both challenge conditions, no-eye contact, and direct stare threat by a human intruder. Cynomolgus macaques were significantly more fearful and reactive when compared to rhesus macaques. Cynomolgus macaques behaved more aggressively towards a human intruder, while bonnet macaques showed little fear or hostility. Together these findings demonstrate significant species differences in socioaffective behavior. Furthermore, this study provides the first validation of the behavioral assessment in cynomolgus and bonnet macaques. The demonstration is important as foundational data for a range of studies to test neural and behavioral genetic hypotheses in nonhuman primates.

101. MULTIPLE UNIQUE, ADAPTIVE SHIFTS IN LIFE HISTORY ACROSS PRIMATES CORRESPOND TO SHIFTS IN DIET

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The evolution of life history is intimately related to other traits including body size, and ecological factors such as population density. Evolutionary shifts in optimal life history strategies should then correlate to shifts in other traits such as diet, habitat use, or sociality. We compiled data on morphology, life history (LH), environment and diet for 100+ taxa to test these hypotheses: 1) there are multiple evolutionary shifts to unique optimal LH strategies, and 2) LH traits are predicted by diet and/or environment. Diet is the strongest predictor of LH, with shorter IBI and weaning times in folivores than frugivores or omnivores (LRT vs null = 7.10, p=0.03). An adaptive peak with high selective constraint (alpha parameter ~0.15) best fits the relationship, suggests strong evolutionary stasis around LH optima. Annual precipitation does not explain variation in LH. Life history likely evolved towards unique optima with different levels of selective constraint among dietary regimes: folivores have fastest life histories/ weakest selective constraints whereas frugivores and omnivores have slower life histories/ stronger selective constraints. The folivore fast-lane is an adaptive optimum, suggesting nutrition may influence

development more than other aspects of the environment. We thank the SBU, NSF (JPH), and the UM (LLT).

102. A LACK OF DIETARY CONFORMITY IN MIGRATING CAPTIVE CHIMPANZEES (*PAN TROGLODYTES*)?

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Evolutionary theory predicts that natural selection will fashion cognitive biases to guide when, and from whom, individuals acquire valuable social information. One such bias that promotes community specific skills is conformity. In this study, we investigated whether migrating captive chimpanzees would switch behavior to conform to a new dietary population norm. ‘Migratory-minority’ chimpanzees learnt that two food sources, dyed either orange or green, were either palatable or unpalatable, before ‘migrating’ (through colony re-organisation) to, and then observing, groups trained with opposing food color preferences. Following migration and when presented with untreated orange and green food, both ‘migratory-minority’ (7 of 8 chimpanzees) and ‘local-majority’ chimpanzees (17 of 21 chimpanzees) relied upon personal information, preferentially consuming first the food they earlier learned to be palatable (24 of 29: Binomial, $P=0.007$). However, both ‘migratory-minority’ chimpanzees ($MD = .80$) and ‘local-majority’ chimpanzees ($MD=.74$), spent proportionately less time consuming their known palatable food than did control groups ($N=12$ individuals, $MD=1.00$) that had no migrating chimpanzees following their induced food preferences ($U=11.00$, $N=19$, $P=0.005$; $U=45.00$, $N=32$, $P=0.005$, respectively), indicating that while chimpanzees initially relied upon personal information, opposing social information promoted exploration of what other chimpanzees chose to eat. The observed initial reliance on personal information, coupled with the ‘local-majority’ chimpanzees’ dissent from an established group norm, suggests that chimpanzees did not engage in conformist social learning strategies in this context.

103. VARIATIONS IN THE MU-OPIOID RECEPTOR INFLUENCES MATERNAL BEHAVIOR AND INFANT OUTCOMES IN RHESUS MACAQUE

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Research shows that variation in an OPRM1 SNP (C77G) in rhesus monkey (*Macaca mulatta*) mothers and infants are associated with variation in mother-infant attachment and behavior. We propose a study that investigates the role of mu-opioid genotype variation in maternal and infant behaviors. Behavioral data measuring mother-infant behavior and other home-cage social interactions were collected from 42 mother-infant pairs. Subjects were genotyped for the OPRM1 genotype, and mixed design repeated measure ANOVAs were run using weekly measures of 18 mother-infant behaviors over the first 24 weeks of life, using the infants’ genotypes and sex as between-subject factors. Mother freezing (lack of activity and social proximity to conspecifics) was associated with infant genotype and infant sex ($p= 0.04$). Mothers of CG males expressed more freezing than mothers of CG females, whereas mothers of CC females exhibited more freezing than mothers of CC males. Maternal restraint showed a nearly significant sex by genotype

interaction ($p=0.058$), with mothers restraining CC males more than CC females, and mothers restraining CC infants more than CG infants. These results are consistent with other studies showing that the OPRM1 gene plays a role in mother-infant relationships, and that mothers of infants with the G allele behave differently than mothers of infants with the CC genotype, and add to the research by showing that it is likely mediated by infant sex.

104. ELO-RATING AS A TOOL TO MEASURE RANK CHANGES AND DOMINANCE STABILITY IN SEMI FREE RANGING RHESUS MACAQUES

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Rhesus macaque (*Macaca mulatta*) society is generally considered a stable linear hierarchy in which individuals inherit maternal rank and very seldom change in dominance, except when younger sisters grow to outrank their older sisters. However, in a group of approximately 80 semi-free ranging rhesus macaques at the NIH Laboratory of Comparative Ethology field station, we have anecdotal evidence of revision in dominance resulting from major events, such as the death of high ranking females, significant fights, and temporary removal from the field for medical treatment. A relatively new method of assessing dominance in animals, Elo-rating, uses sequential interactions to constantly update ratings and has been proposed to both track changes in dominance over time and measure rank stability, which typical matrix based models cannot readily do. We tested the hypothesis that our anecdotal evidence of major events could be mapped onto Elo-rating results to pinpoint the circumstances for dominance fluctuations. We generated Elo-ratings for 84 individuals based on 2,027 opportunistically observed dyadic interactions between February 2013 and January 2015. We analyzed the Elo-ratings surrounding $N=24$ major events and found that the ratings significantly changed after these events ($Z=-2.286$, $p=0.022$). These results address the prevailing assumption of stability in rhesus macaque society by offering a new tool for tracking changes in dominance rank over time.

105. TESTING THE ORIGINS OF PRIMATE ANTERIOR ORBITAL CONVERGENCE AS A FUNCTION OF EVASIVE LEAP LANDING AND REDUCED POSTERIOR PREDATION

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Terrestrial predation on much of the planet's two-dimensional surface can be exemplified by larger predators pursuing smaller prey who use peripheral vision along with numerous, sudden directional changes during potentially prolonged pursuit. These dynamics were dimensionally altered when primates evolved anatomy specialized for arboreal avoidance. Appendages that embrace (rather than claw into) substrate enable refuge from larger terrestrial specialists because a high body to branch size ratio can render predation infeasible in a fractally slendering terminal branch topology. An extinct family of non-burrowing, legless, large-gaped, constricting reptiles (madtsoiids) could have overcome this size ratio barrier in the late Cretaceous when grasping Euprimateformes were first emerging. Frequent leaping has been suggested as serving as an anti-predation locomotor strategy in prosimians. I extend this idea by hypothesizing that leaping

specializations in primates first evolved as a snake predation avoidance mechanism. Absent substantial (terrestrial) predation from their posterior, (strictly arboreal) primates may have instead evolved anteriorly convergent vision for landing leaps as part of expeditious evasion from this new serpentine threat to its terminal branch refuge. I test this theory using phylogenetic generalized linear regression on quantitative leaping data for 61 species collected from locomotor studies, and data from a study that recently tested Isbell's snake detection theory (Wheeler 2011). Leaping frequency and body mass had significant and positive associations with orbital convergence, while the controls (e.g. anatomy, frugivory, and nocturnality) did not. Better measures for various predation risks on primates are needed to help understand the conflicting selection pressures on orbital orientation and to resolve the evolutionary chronology of detection, evasion, and avoidance.

107. ADDITIONAL WELFARE BENEFITS OF INNOVATIVE SHELTERS CONSTRUCTED TO PROTECT CAPTIVE RHESUS (*MACACA MULATTA*) MACAQUES FROM EXTREME WEATHER CONDITIONS

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Most large nonhuman primate breeding centers in the USA use corrals and field cages to house social groups of Indian-origin (IO) rhesus macaques (*Macaca mulatta*). In South Carolina, the temperature ranges are similar to the natural habitats of IO macaques. Extremely low temperatures were forecasted during the winter of 2013-2014. The facility decided to create additional shelters for animals located in their field cages. Hay ring feeders were chosen for a pre-made structure that could be rapidly covered with HDPE (high density polyethylene) sheets. Two of the three parts of the hay rings were joined together and then covered with HDPE sheets, making an arched structure where animals could take shelter from the elements. We observed additional enrichment benefits as the juvenile (1-3 years) used the inner structure as “monkey bars” and the outside panels as slides. Statistics showed fewer aggressions resulting in clinic treatments the months after the shelters were installed as compared to the same period the previous year. Therefore, these shelters have provided additional benefits beyond simply sheltering animals during the winter months. Our goal is to share this simple and low-cost application with other breeding facilities to positively impact the overall welfare for captive rhesus monkeys in social groups.

110. THE LEGACY OF PLACENTAL FUNCTION IN PRIMATE BRAIN DEVELOPMENT AND EVOLUTION

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In studies of primate brain evolution, the emphasis is on adult brain function and selection for adult cognitive or social traits. However, the intrauterine environment in which the brain develops has enormous implications for postnatal function. The placenta is an essential conduit of maternal nutrients to the fetus. Shifts in placentation and encephalization appear to be associated within the primate lineage, with many researchers suggesting that some unique aspects of primate, and especially hominine, placentation were necessary to drive phylogenetic increases in brain size.

Few studies have directly explored that relationship. In this talk, I will discuss intrauterine processes that set the stage for the expanded size and function of the primate brain. In particular, the developing primate brain is dependent on a steady supply of glucose, the transport of which flows from maternal blood to the fetus via microscopic placental structure and transporter activity. My Legacy Award has allowed me and an interdisciplinary team to apply magnetic resonance imaging to a series of vervet monkey (*Chlorocebus aethiops*) fetal brains, to test the hypothesis that variation in placental surface area and glucose transporters across gestational time points predicts growth and differentiation of the brain. I will present my findings, future directions, and the clinical and theoretical implications of an empirically rigorous study of the placental legacy of brain development and evolution.

112. RECENT FINDINGS IN CHIMPANZEE WELFARE

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Over the last twenty-five years there has been tremendous progress in the behavioral management of chimpanzees to improve their welfare. Recently there has been increased regulatory attention directed toward the welfare of chimpanzees, and interest from the general public remains high. This symposium will include speakers who study chimpanzee behavior in laboratories, zoos and sanctuaries, focusing on key areas relevant to welfare. One presentation will report on abnormal behavior in zoo-housed chimpanzees, and a second will report on welfare measures for laboratory-housed chimpanzees. A behavioral comparison will be made between chimpanzee groups provided with varying amounts of space. Managing aggression is a common problem, and one presentation will describe wounding rates for group-living chimpanzees. Another will compare social behavior before, during, and after introduction procedures for groups of varying size. Positive reinforcement training has become an important tool in caring for chimpanzees, and two presentations will provide assessments of training chimpanzees to voluntarily cooperate with presenting for injections using varying techniques. The final presentation will compare standards of care and regulation across different types of facilities housing chimpanzees. Advances in the areas of behavioral assessment, enclosure design, social group management, animal training methods and the regulations pertaining to chimpanzee care are all contributing to continued improvement in captive chimpanzee welfare.

114. MALE AND FEMALE DISPERSAL IN WILD RINGTAILED LEMURS (*LEMUR CATT*): GENETIC EVIDENCE

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With the advent of molecular methods, it is now possible to augment observational studies of dispersal with genetic data. We evaluated dispersal patterns in two *Lemur catta* populations in southwestern Madagascar, Tsimanampesotse National Park (TNP) and Beza Mahafaly Special

Reserve (BMSR), using behavioral and molecular data. Behavioral studies have concluded that this species shows male-biased dispersal and female philopatry. However, female dispersal has been observed in at least two *L. catta* study sites, including BMSR, posing the question of whether genetic data would show evidence of female dispersal. We genotyped over 200 individuals to test for a sex-bias to dispersal using corrected assignment indices. We also determined the level of genetic differentiation between our study populations, which are approximately 135 km apart. Our results showed only minor genetic differentiation between the populations (θ -ST=0.039; $p < 0.001$), which may indicate that gene flow has historically occurred in this region, made possible by the presence of *L. catta* groups between the two study sites. From molecular data, we found evidence of male-biased dispersal in TNP ($p = 0.002$) but not in BMSR. Observations of female dispersal into BMSR from outside the reserve (and within the reserve) support these molecular results, and may imply intense female resource competition in and around BMSR. In sum, our behavioral and molecular data provide support for male and female dispersal in this species.

117. BEHAVIORAL INDICES OF WELFARE IN A LARGE SAMPLE OF LABORATORY CHIMPANZEES

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Behavioral assessment is an essential element of chimpanzee care. Behavioral data were compiled from three chimpanzee laboratory facilities (N=340; 201 females, 139 males) using differing methods of assessment including quantitative data collection, animal records and observations by behavioral management staff. The subject pool contained 46% mother-reared (MR), 41% nursery-reared (NR), and 13% other-reared chimpanzees. Mean group size was 4 (range 2 to 14), 100% had access to outdoor space all year, and 65% had access to a natural substrate. The presence of species-typical chimpanzee behaviors was surveyed: 96% of the subjects used tools to acquire food; 77% built nests; and 73% copulated. Fifty-eight percent of the subjects showed one or more abnormal behaviors; the most common was coprophagy. Ninety-nine percent were reported to generally voluntarily cooperate with requests to shift, 99% show at least one body part for examination, and 72% present for an anesthetic injection. Chi-square analyses revealed NR animals were less likely than MR to use tools (Chi-square = 9.97, $p = .007$), build nests (Chi-square = 62.51, $p = .000$), copulate (Chi-square = 45.79, $p = .000$), and display coprophagy (Chi-square = 11.33, $p = .003$) or hair-plucking (Chi-square = 8.40, $p = .015$). This analysis will help guide future improvements in behavioral management to address existing behavioral problems or deficits.

118. EVALUATING THE ROLE OF PARTNER PREFERENCE AND INTER-SEXUAL AGGRESSION IN THE MAINTENANCE OF EARLY AND LATE-STAGE SOCIALLY MONOGAMOUS PAIR BONDS.

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Selective partner preference and inter-sexual aggression are key behavioral components of social monogamy. However, their temporal stability and relative contribution to maintaining pair bonds is not well understood. We evaluated these behaviors in seventeen pairs of socially monogamous titi monkeys (*Callicebus cupreus*). Nine pairs represented early-stage (6 mo. paired) and eight represented late-stage bonds (avg. 38 mo. paired). We tested individuals in a three-chambered partner preference test for three hours. The subject was placed in the middle chamber separated with a grated window from its pair-mate on one side and an opposite sex stranger on the other. The proportion of time the subject spent in proximity with and touching each window was recorded. A General Linear Mixed Model revealed that partner preference was apparent in both early [$p < .01$] and late-stage [$p < .01$] pairs as measured by proximity. Early-stage pairs tended to spend more time in proximity with their partner than individuals from late-stage pairs [$p = .06$]. Late-stage pairs spent significantly less time touching the window of their partner compared to early-stage pairs [$p < .01$], whereas touching the window of the stranger did not differ across pair-bond tenure. These results suggest that selective partner preference is more robust during early stages of pair-bonding, and that other behavioral components of social monogamy may be more important to long-term maintenance of pair bonds.

119. CHIMPANZEES RESPOND DIFFERENTLY TO INEQUITY BASED ON RELATIVE FOOD VALUES

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Recent evidence shows that chimpanzees (*Pan troglodytes*), like humans, react negatively to inequity in some experimental situations. The social inequity hypothesis suggests that subjects respond to social inequity, predicting diminished participation upon receiving lower value food than others, and that food rejections increase. The food expectation hypothesis suggests that subjects expect to receive the same higher value food as others, predicting that participation would increase upon receiving lower value food. We tested 11 subjects in 4 social groups in an hour-long token exchange paradigm with low-, medium-, and high-value foods present. Subjects were tested twice each in three inequity conditions, and twice each in three control conditions. We analyzed subjects' responses across conditions, and to receiving a medium-value food reward when it was of relatively higher or lower value than other foods. Subjects rejected more food in inequity conditions in which other participants received higher value food, compared to control conditions in which all participants received the same value food (Friedman $\chi^2(1)=4.455$, $p=0.035$), replicating results of prior studies. Critically, subjects exchanged more tokens for medium-value food when it was of relatively higher value than the food that others received during a session, as compared to when the medium-value food was of lower value than the others' food (Friedman $\chi^2(1)=4.545$, $p=0.033$). These data support the social inequity hypothesis, rather than the food expectation hypothesis.

120. ASSESSING QUANTITY OF SPACE FOR CAPTIVE CHIMPANZEE WELFARE

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A literature review and summary of expert recommendations conducted by the National Institutes of Health (NIH) concluded that captive chimpanzees (*Pan troglodytes*) should have a minimum of 250 ft² per animal. However, few quantitative data exist to assess the effects of quantity of space and animal density on the behavior of captive chimpanzees. The current study assessed the behavior of chimpanzees living in areas that were either smaller or larger than the new recommended living area. We collected 601 hours of group scan data from 167 subjects living in either: corrals that exceeded the new living area recommendations (416-654 ft²/individual; N=109); or primadomes™ with less available space than the recommendations (172-244 ft²/individual; N=58). Activities recorded included feeding, inactivity, locomotion, agonism, grooming, social play, self-grooming, self-directed play, and abnormal behavior. There were no significant behavioral differences between the animals living in the corrals or in primadomes™, except for social play, $t(165)=3.088$, $p=0.002$. Chimpanzees played approximately 0.7% and 0.2% of the time in corrals and primadomes™, respectively. Overall, our data suggest that the behavioral differences between living in a primadome™ (<250 ft²/chimpanzee) or a corral (>250 ft²/chimpanzee) are negligible. Both primadomes™ and corrals are highly enriched spaces, emphasizing that quality of the space available to captive chimpanzees may be more important than quantity of space available.

121. MEANDERING AND MARCHING: GROUP MOVEMENT AND INDIVIDUAL BEHAVIOUR IN BABOONS

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Group behaviours are the outcome of individual-level interactions among group members, where individuals are thought to be predominantly reacting to, and altering, local social and ecological conditions. In heterogeneous groups, individuals of different age, rank, sex, and knowledge deal with a large array of information, but are thought largely to rely on simple rules. We measured movement patterns, capturing individual positions during daily movements (N=77 days), of a troop of baboons in De Hoop Nature Reserve, South Africa. We find that at the group level, movements largely fall within two modes of travel: marches and meanders. A K-means classification using speed and tortuosity of travel selected two classes: slow and tortuous vs. fast and straight travel events (average silhouette width = 0.61). We found differences in the spatial patterning. Associations between individuals were more frequent during meandering and showed lower measures of network centrality (e.g., closeness centrality: marching 0.36, meandering 0.10). Animals were more widely spread during marches (mean inter-individual distances: marching 6146 m, meandering = 5721 m, Cohen's $d = 0.3$). To explain this movement dichotomy and the resulting spatial structures, we make use of simulation models to test between possible

individual-level rules leading to observed group marches and meanders. The ability to test individual-level behavioural hypotheses in a structured way using simulations is discussed, as are opportunities for combining spatial and behavioural datasets.

122. SQUIRREL MONKEYS DEMONSTRATE THE IDENTITY CONCEPT ON A MATCH-TO-SAMPLE TASK

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By comparing two stimuli and understanding a relation between them, an animal can form a relational concept. One such concept is the identity concept, in which an organism recognizes the sameness between stimuli. A common method for investigating the identity concept is a match-to-sample (MTS) paradigm. We tested for the identity concept in squirrel monkeys (*Saimiri sciureus*) using a simultaneous two-choice MTS task. Monkeys were presented with a stimulus image on a touch screen and, when they touched this sample stimulus, two stimuli would appear as choices below the sample. Monkeys were rewarded for selecting the matching stimulus. Of six monkeys that underwent MTS training, only one learned the task. In 20-trial sessions, she correctly selected significantly more often than chance ($p < 0.05$ binomial test) after 236 training sessions. When this monkey was presented with a novel pair of transfer stimuli, she matched over chance in her second test session. On her fourth pair of novel stimuli, she matched over chance during her first test session. Although five monkeys did not perform the matching task after a median of 278 training sessions, spontaneous transfer of matching ability to novel stimuli by one monkey indicated that squirrel monkeys could formulate an identity concept. To our knowledge, the result was the first time the identity concept has been demonstrated in this New World monkey species.

123. WOUNDING RATES IN CAPTIVE SANCTUARY CHIMPANZEES (*PAN TROGLODYTES*)

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Aggression that results in wounding concerns all managers of captive chimpanzee facilities and with recommendations for larger, complex social groups it will remain a concern into the future. Subjects were 173 chimpanzees (89 F, 84 M, age range 0-54, mean = 30.4, average group size = 7.67) housed at Chimp Haven, Inc. Location and severity of the wound, as well as any veterinary intervention were recorded. Wounds that required no veterinary intervention were categorized as minor. Those that required painkillers, antibiotics, topical treatment, sutures, amputation, or sedation were considered major. Wounding rates were used for analysis as our population changes regularly due to incoming chimpanzees, deaths, and introductions. Between January 1, 2007 and July 10, 2012, 837 wounds were recorded (90.08% minor, 9.92% major; mean wounding rate = 1.36 per year). Males received more wounds (1.77) than females (.97) ($t = 1.99$, $p < 0.05$) overall and in both the major and minor categories ($t = 1.87$, $p < 0.05$ minor; $t = 1.96$, $p < 0.05$ major). Adolescent chimpanzees (10-13) had the highest rate of wounding (1.53) followed closely by adults 14-44 (1.41). Older chimpanzees (44+) had reduced wounding rates (1.04). This study found no differences in rates of wounding between age-sex categories. It will

be important to monitor any variation in wounding rates as additional chimpanzees are retired and larger groups are formed.

124. INDIVIDUAL DIFFERENCES IN THE AFFILIATIVE, PLAY, AND ACTIVITY BEHAVIORS OF CAPTIVE BONOBOS (*PAN PANISCUS*)

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Bonobos exhibit a diverse repertoire of social behaviors, and are thus an ideal species for the investigation of stable individual differences in multi-trait social behavior. Previous bonobo personality research has been limited by small sample sizes ($n = 4-5$) or the use of observer ratings. The present study seeks to address these issues by using behavioral observation methods to assess the social personality traits of captive bonobos. As predicted by prior questionnaire research, it was hypothesized that the subjects would exhibit stable individual differences in their affiliative, play, and activity behaviors (locomotion, foraging, etc.). Data were collected via instantaneous and 1-0 sampling during 1 hr focal animal observations ($N = 216$) rotated among adult and juvenile subjects ($n = 10$) at the Cincinnati Zoo between September 2014 and May 2015. One-way ANOVAs with subjects as fixed factors were conducted for 106 hr of preliminary data. The results suggest that the subjects significantly differed in their mean frequency of affiliative [$F_{(9,96)} = 5.85$; $p < .001$], play [$F_{(9,96)} = 2.65$; $p = .009$], and activity [$F_{(9,96)} = 5.80$; $p < .001$] behaviors during fall 2014. These and other behaviors exhibited moderate repeatability (r) across 1 hr sampling periods (range = 0.14 - 0.69; mean = 0.32), providing initial support for the hypothesis that bonobos exhibit stable personality differences in their social behavior.

125. HOW ECOLOGICAL VALIDITY INFLUENCES THE PERFORMANCE OF FISH (*LABROIDES DIMIDIATUS*) AND PRIMATES (*CEBUS APPELLA*) IN A FORAGING TASK

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The ecological approach to cognition challenges the classical view that advanced cognitive skills are correlated with larger brains. Previous studies have shown that cleaner fish may outperform primates in a foraging task designed to be ecologically relevant to them. To draw the conclusion that this is entirely due to ecological validity, however, we must also demonstrate the reverse, namely that primates succeed better than fish in an equivalent task more relevant to primate ecology. We addressed this question by comparing both taxa in versions of this task designed to be more primate-relevant. First, we investigated whether food presentation influenced performance; in particular, whereas fish consume identical foods from different sources, primates consume different foods from different sources, so we explored whether differences in the foods themselves, rather than how the food was presented, made the task easier for primates. Second, we tested whether performance improved when the foods were hidden. Primates improved their performance in these adapted tasks as compared to the original (Paired t-test, two-tailed, all $ps < 0.05$) whereas fish did not (Paired t-test, two-tailed, all $ps > 0.05$), which supported the view that both species are likely selected to solve problems that are naturally relevant to them. We

argue that testing species on two different tasks, each of which being only relevant to one of them, is the strongest test of the ecological view of cognition.

126. CAPTIVE CHIMPANZEE (*PAN TROGLODYTES*) BEHAVIOR DURING SOCIALIZATION PROCEDURES

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Three different groups of chimpanzees were formed and monitored through 41 introduction and post-introduction data-collection sessions. One male chimpanzee and seven female chimpanzees were involved in the formation of these groups. Analyses of 28.6 hours of behavioral data revealed significant differences in chimpanzee behavior during introduction phases versus post-introduction phases. Affiliative behavior (excluding grooming) ($U = 62.5$, $p = .000$), aggressive behavior (both noncontact, $U = 155.0$, $p = .001$, and contact, $U = 88.0$, $p = .008$), submissive behavior ($U = 80.5$, $p = .000$) and sexual behavior ($U = 149.5$, $p = .008$) were all found to occur at a higher frequency (rate per minute) during introductions. Stress behavior, grooming behavior, dominance behavior and abnormal behavior were not significantly different between the two phases. Both groups of chimpanzees, one of four adult females and the other of one adult male and three adult females, were successfully formed, though one group required several separations and reintroductions. As facilities work towards building larger, more complex groups of chimpanzees, it is important to collect and share information about the behavior of chimpanzees during and after socializations as well as to investigate possible early predictors for success.

127. FEMALE COMPETITION IN ZOO LIVING MANDRILLS (*MANDRILLUS SPHINX*): EFFECTS OF DOMINANCE RANK AND REPRODUCTIVE STATE

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It is hypothesized that female-female competition will be most intense during sexual swelling, as the potential for reproductive success is highest. Therefore, we used sexual swelling as an indicator of reproductive state to test the following predictions on a captive group of mandrills at San Francisco Zoo: (1) Dominance interactions (DI) and sexual swelling are associated; (2) The dominant female engages in more DI while fully swollen than subordinate females. We employed continuous sampling, consisting of 30 minute observations, collected between August-December 2014 (60 hrs.). Our sample of females was small ($N=3$) and sexual swellings were categorized: 1=no swelling, 2=some swelling, 3=fully swollen. The female dominance hierarchy consisted of the 1st dominating the 2nd ranked female, and the 2nd dominating the 3rd ranked female. DI were associated with sexual swelling ($\chi^2=6.143$, $p<0.05$). 84% of the DI between the 1st and 2nd ranked females occurred when the 1st ranked female was fully swollen (goodness-of-fit: $\chi^2=37.805$, $p<.001$). DI between the 2nd and 3rd ranked females were not associated with sexually swelling. Compared to the 2nd, the 1st ranked female engaged in more DI when fully swollen (multinomial regression: $\text{Exp}(B)=46.286$, $p<.001$). These data offer some support for the 1st ranked female engaging in more dominance interactions when fully swollen—that is, the

dominant female is apparently more competitive when the potential for reproductive success is highest.

128. WHAT IS THE CONTRIBUTION OF MEMORY ERROR TO CHIMPANZEE FORAGING EFFICIENCY?

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Chimpanzees are capable of rank ordering the expected value of hidden food items by item type, quantity, proximity, and the amount of time since viewing. We hypothesized that a subset of all items is maintained in active memory. When higher value items are removed from the decision space, lower value items rise in activation. If an essential feature (e.g. location) of the best available remaining item is not retrieved from memory, the corresponding feature from a similarly ranked goal is substituted. Thus, memory errors are expected to preserve the value of the next recovered item. We examined errors shown by three adult chimpanzees in foraging tests that required animals to remember multiple items and features of items. The apes sometimes failed to recover highly valued items, mislabeled the type of item hidden in a location by lexigram, or designated an incorrect location in response to an experimenter-initiated query. Substitution errors for “what” and “where” components of an event, appeared to result from adaptive mechanisms that alter levels of memory activation and inhibition. Analysis of errors suggests that a similarity principle in goal substitution maintained foraging efficiency after 24-h retention intervals. Supported by Leakey Foundation, HD056352, and HD060563.

129. EFFECTS OF PARTICIPATION IN POSITIVE REINFORCEMENT TRAINING ON HEMOGRAM AND CHEMISTRY PARAMETERS IN CHIMPANZEES (*PAN TROGLODYTES*)

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Previous research suggests that positive reinforcement training (PRT) helps alleviate stress during potentially distressing events, such as anesthesia for physical examination, as indicated by changes in certain hematology values including white blood cell (WBC) counts, neutrophils (NEU), and glucose (GLU) levels. We consider the effects of PRT by comparing hematology levels of chimpanzees that were trained for voluntary IM injection versus untrained chimpanzees. One group of trained subjects had previous PRT experience (Exp; n=35, 14F, 21M; 3.5-15.17 yrs; mean=8.33) while another group of trained subjects were naïve to PRT (Naïve; n=11, 11F; 12.67-26.83 yrs; mean=18.71) prior to voluntary IM injection training. The third group of subjects remained untrained (Unt; n=27, 10F, 17M; 3.33-19.08 yrs; mean=14.22). Data were obtained from two annual physical examinations for each subject. For trained subjects one, data point was collected prior to onset of voluntary injection training and one after reaching training criteria. Among trained subjects WBC and NEU levels were significantly lower (WBC and NEU: Exp<Unt, p<.05; NEU: Naïve<Unt, p<.05), while GLU (Naïve>Unt, p<.05; Exp<Naïve, p<.05) was significantly higher. No effect of cooperation with injection was observed suggesting that PRT for voluntary injection lowers the stress responses of chimpanzees to sedation procedures, whether or not the subjects voluntarily present for injection. Additionally, continued participation

in PRT for voluntary injection may result in increased cooperation with injection during subsequent sedation procedures.

130. VISITOR EFFECTS ON THE BEHAVIOR OF AND EXHIBIT USE BY CHIMPANZEES AND GORILLAS AT LINCOLN PARK ZOO

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Several factors, including facility design and group composition, are known to affect the overall well-being of captive apes. Previous studies have also recognized the influence of human presence and interaction on the behavior and welfare of these animals. But while the effects of crowd size/density have been studied in many zoo-housed animals, including gorillas (*Gorilla gorilla*) and chimpanzees (*Pan troglodytes*), the degree to which visitors affect these apes remains open to investigation. We aimed to determine how chimpanzees (n=6) and Western lowland gorillas (n=5) housed in the Regenstein Center for African Apes at Lincoln Park Zoo responded to crowds of various sizes. The dataset, gathered over 12 consecutive months, included both behavioral data, collected via focal animal follows, and space use data, collected via whole group scans. The number of visitors near each exhibit was recorded at the start of each observation session. Crowd size had no effect on the frequency of any behavior analyzed, including locomotion, feeding, grooming, and self-directed behaviors. Likewise, as crowd size increased neither chimpanzees nor gorillas were observed to alter their use of the areas of their exhibit within close proximity (1 meter) of the public floor. These findings suggest that modern, well-designed zoo exhibits can be effective in removing the potentially negative effects of large crowds described elsewhere.

131. CHIMPANZEES (*PAN TROGLODYTES*) ASSESS POTENTIAL BENEFITS BEFORE INVESTING IN A COOPERATIVE TASK

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In any cooperative investment, there is a risk of leaving empty-handed. While cooperation in primates has attracted considerable research, little is known about the extent to which they assess outcomes before they invest. In this study, we examined whether chimpanzees are sensitive to changes in reward certainty. A captive group of 13 animals had simultaneous access to a cooperative task that required three individuals to pull a tray baited with food toward them. Potential rewards were clearly visible to the chimpanzees. Reward rates were manipulated across thirty 60-minute test sessions so that each location was baited independently, with a probability of either 0, .2, .4, .6, .8, or 1. Within a session, reward rates were the same for all three locations. Cooperation increased significantly, yet not proportionally with higher reward rates, indicating that success was not determined by reward contingencies alone, MANOVA $\Lambda=1.08$, $F_{(10,48)}=5.58$, $p<.001$, $\eta^2=.54$. Specifically, chimpanzees switched positions less frequently in sessions with certain outcomes (guaranteed gains or losses for all partners) than those with uncertain outcomes, ANOVA $F_{(5,24)}=6.07$, $p=.001$, $\eta^2=.56$. These results underscore that chimpanzees flexibly respond to potential risks and benefits before they engage in cooperative

efforts. By assessing outcomes prior to investing, chimpanzees ensure successful and efficient cooperation.

132. POSITIVE REINFORCEMENT TRAINING TO VOLUNTARILY PRESENT FOR INJECTION: IDENTIFYING FACTORS TO PREDICT COOPERATION WITH INJECTION OF ANESTHESIA IN CHIMPANZEES

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The chimpanzee training program at the Yerkes National Primate Research Center prepares chimpanzees for anesthetic injections by using positive reinforcement training techniques. Training session and anesthetic injection outcomes were assessed over a three-year period for 71 chimpanzees, across 118 cases when they were anesthetized. Seventy percent of the chimpanzees voluntarily presented on at least one occasion. There was no sex difference in the proportion of subjects who were successful (53% of females, 64% of males; $t(62), = -0.86, p = 0.39$). Data were analyzed to determine training steps which may predict presenting for an anesthetic injection. The number of times chimpanzees had a needle perforate their skin during training sessions did not correlate with proportion of times they presented for an anesthetic injection ($r = 0.15, p = 0.24$), nor did the number of present for injection training sessions ($r = 0.14, p = 0.27$) as measured by Pearson correlation. Fisher's exact test indicated that accesses for chimpanzees who were trained with at least one temporary separation from their groups during 6 months prior ($p = 0.048$) or 6 sessions prior ($p = 0.003$) to an anesthetic injection were more likely to present. Behavioral managers, researchers and veterinarians can apply this information to best prepare chimpanzees for successful injections, an important aspect of promoting the welfare of captive chimpanzees.

133. A COMPARISON OF PROXIMITY VALUES BETWEEN CHIMPANZEES (*PAN TROGLODYTES*) IN A STABLE AND UNSTABLE GROUP

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Captive chimpanzees introduced to larger multi-male groups may develop changes in the male dominance hierarchy over time. These changes may affect how often males associate with each other as a threatened alpha seeks allies to assist him. Proximity data were collected on two multi-male groups to determine differences in proximity scores between a stable group (Ed, $n = 14$; $M=6, F=8$, age range 22-54, mean 36.6) and an unstable group (Kasey ($n = 14$; $M=5, F=9$, age range 23-52, mean 34.2). Stability of the hierarchy was based on the frequency and severity of wounding of the alpha male (Ed = 0 wounds, Kasey = 9 wounds) in the preceding 3 months. Proximity was defined as being within 1m of another chimpanzee. We expected lower scores in the unstable group due to the alpha male's attempts to elicit support from more individuals. The proximity values between females (F-F) in Ed's group were higher than those in Kasey's group ($z = 2.29, p = 0.02$) but the values between the males (M-M) did not differ ($z = -0.60, p = 0.54$). Males in both groups tended to spend more time in proximity to other males than females ($z = 1.90, p = 0.06$). In this study hierarchical instability may have affected female proximity scores, but not male scores, suggesting that hierarchy changes might also affect female associations.

134. THE BEHAVIORAL MECHANISMS THAT ALLOW CHIMPANZEES TO COOPERATE WHEN REWARDS ARE UNEQUAL

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Cooperative events in the wild involve many variables that have not typically been tested when studying cooperation in captivity. We recently used free access to a device requiring 3 individuals to work at the same time to better model the richness of chimpanzee cooperative interactions in the wild. But, all 3 chimpanzees received the same reward, and in the wild resources are not always divided evenly. To incorporate unequal outcomes, we placed 3 grapes at two of the locations and 1 grape at the other location. When the apparatus was unoccupied, chimpanzees preferred to approach the locations with 3 rewards, which demonstrated understanding of the reward differences and motivation for the higher amount. The chimpanzees succeeded at the task almost 700 times in 20 1-hour sessions, showing tolerance for unequal outcomes. Looking at the mechanisms for this tolerance, access to the high value locations seemed to be determined by rank, which may have limited aggression. Low rank may have allowed acceptance of the lesser amount (a grape is still a preferred item) and relative distribution. For chimpanzees, rank may enable cooperation when rewards are moderately unevenly distributed. It remains to be seen how extreme inequity and effort may influence rates of cooperation.

135. COMPARISON OF STANDARDS AND OVERSIGHT OF CHIMPANZEE CARE AND WELFARE ACROSS HOUSING SETTINGS

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More than half of the chimpanzees living in the US are housed in zoological parks, sanctuaries, and other settings, while the rest live in research facilities. The current regulatory system in the US is based in categorization according to the purpose, or type of “use” of nonhuman animals. As a result of this structural characteristic, the system results in inherent inequalities for standards, oversight, and protection of the welfare of nonhuman primates. Recent federal decisions about the long-term care of US federally-owned chimpanzees highlight long-standing and unresolved questions about equity in treatment, regulatory protection, and ethical decision-making about apes, regardless of the settings in which they live. Comparison of the different standards and settings can inform evaluation of equitable treatment, identify potential routes for reconfiguration of the current system, and assist continued evolution of practices and policies that best serve the animals’ welfare. The evaluation of long-term care for federally-owned chimpanzees underscores the value and need for scientifically-informed consideration of the welfare of all captive apes, regardless of the setting in which they live. The recent decisions also highlight the need for a broader framework for consideration of policy and practice decisions that take into account the balance of potential benefit and potential risks at the level of likely welfare outcomes for individuals, species, society, and the environment.

136. INDIVIDUAL DIFFERENCES IN CHIMPANZEE (*PAN TROGLODYTES*) PERSONALITY, LEARNING, AND ENGAGEMENT IN TOUCH SCREEN TASKS

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Impressive degrees of individual psychological differentiation exist in a wide range of primate species. Human work has long viewed personality and intelligence as intertwined, but in animal work it is more difficult to tease apart performance from motivation, particularly in participatory experiments. Additionally, previous work on primate cognition has not focused on measuring intelligence concurrently with engagement. Our aim was to examine chimpanzee cognitive performance on and behavior surrounding several touch screen tasks, using personality and engagement behaviors to control for variation in individual approaches to cognitive testing. 18 chimpanzees at the Edinburgh Zoo were given participatory access to a series of touchscreen tasks. Three variations on a 2-alternative forced choice task were made available over the course of 3 years. Performance and behavioral data were collected for all tasks. Personality was assessed using the Hominoid Personality Questionnaire. Associations were characterized between personality dimensions and chimpanzees' signs of interest, including proximity to the apparatus, length of time and number of trials per session, frequency of engagement, and performance. Multivariate models indicate that while Openness predicts performance ($\text{Chi}^2=4.46$, $p<0.05$), other personality dimensions, such as Dominance and Neuroticism, also influence individual chimpanzees' engagement. Selection bias may skew the results of cognitive testing, but controlling for personality will allow us to form a more comprehensive understanding of primate learning and intelligence.

139. MY LIFE WITH COTTON-TOP TAMARINS: RESEARCH FOR CONSERVATION AND HUMAN BENEFIT

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My research with cooperatively breeding cotton-top tamarins (*Saguinus oedipus*) began almost 40 years ago with a gift of 11 animals. As stewards of an endangered species it was important for us to develop caging and husbandry to allow successful captive breeding, to create new research methods that would not interfere with breeding or well-being, to learn as much about these tamarins as possible lest they become extinct, and to justify and to support the research through the relevance of this species for conservation and understanding human behavior. I will discuss how we developed a successful breeding colony, why cotton-top tamarins are endangered and how research with captive and field research complement each other and point to some success in conservation. Tamarins (and related marmosets) display many behaviors and capacities of interest to researchers of human behavior that are not seen in other primate models making them an interesting and important alternative animal model. I will provide selective examples involving creating and maintaining pair bonds; mechanisms leading to paternal care; how helpers are recruited and rewarded for cooperative care and how infants benefit from multiple caregivers. I will then present results from our research on the development and flexibility of vocal

communication, teaching, social learning and cooperative behavior. Tamarin research bridges between important areas of primatology to our understanding of origins of human behavior.

141. DOCUMENTING, UNDERSTANDING AND TREATING ABNORMAL BEHAVIOR IN PRIMATES

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Abnormal behaviors are important measures when scientists assess captive primate welfare, as abnormal behavior can be interpreted to indicate compromised welfare. Presentations on a broad spectrum of relevant topics will include measurement, factors influencing abnormal behavior, therapies that have been applied, and methods to prevent the development of abnormal behavior. A documentation system for abnormal behavior that could have broad application will be detailed. A summary of demographic variables that impact self-injurious behavior across a large sample of primates will be presented, as will a longitudinal study evaluating time-related changes in self-injurious behavior. Another will examine relationships among abnormal behavior, stress reactivity, and anxiety. An analysis of alopecia across three facilities will evaluate intrinsic and environmental variables related to hair loss. Two assessments of potential therapies for abnormal behavior will be described--providing additional space for primates as a treatment for stereotyped behavior, and testing supplemental enrichment as therapy for self-biting and self-injurious behavior. Drug therapies used for treatment of self-injurious behavior will be reviewed. Nursery rearing practices that may prevent or delay the onset of abnormal behavior in young macaques will be described. An evaluation of abnormal behavior in nursery-reared mangabeys will include a discussion of surrogate rearing as a means to reduce abnormal behavior. Understanding factors that impact the expression of abnormal behavior is critical in controlling and preventing abnormal behavior.

142. ASSESSING ABNORMAL BEHAVIOR: MEASUREMENT SCALES DEVELOPED BY THE BEHAVIORAL MANAGEMENT CONSORTIUM

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The Behavioral Management Consortium (BMC) is a National Institutes of Health (NIH) working group comprised of the heads of behavioral management at the 8 National Primate Research Centers and other large facilities housing nonhuman primates. This group was established to strengthen communications and facilitate sharing of information and best practices across institutions, both within and beyond the member facilities. An important step towards achieving this goal is to standardize terminology and assessment tools relevant to behavioral management. Such standardization is a critical component to facilitate data sharing and

communication across institutions, particularly with respect to abnormal behavior, a topic approached with surprisingly little uniformity. Pursuant to this goal, the BMC has developed a “Self Injurious Behavior Scale”, which categorizes bouts of self-injurious behavior. This 5-point scale has two categories for non-injurious (i.e., do not cause wounding) incidents-- those that involve self-biting and those that are the result of a behavior other than biting (e.g., head banging). The other three categories are based on the severity of the wound (i.e., mild, moderate, severe). In addition, the BMC developed an “Abnormal Behavior Ethogram” to provide common definitions for abnormal behaviors (e.g., floating limb, pace, spin, etc). Having these shared assessment tools and definitions has fostered communication and allowed cross-center collaborative studies aimed at minimizing the development and improving the treatment of abnormal behavior.

144. THE CRITICALLY ENDANGERED *CHEIROGALEUS SIBREEI* IS DISCOVERED IN HIGH ELEVATION FORESTS IN RANOMAFANA NATIONAL PARK AND THE COFAV CORRIDOR, SOUTHEAST MADAGASCAR

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The lemurs of Madagascar are among the most threatened mammals. The dwarf lemurs (*Cheirogaleus*) are cryptic nocturnal taxa that are especially vulnerable. Their taxonomy is contentious, new species are being discovered, and geographic ranges are inadequately documented. One species, *C. sibreei*, thought to be extinct, is listed as Critically Endangered by IUCN. We surveyed high-elevation habitats in southeast Madagascar to explore the limits of *C. sibreei* range and the widespread congener, *C. crossleyi*. We used live-trapping at four localities: three in Ranomafana National Park (RNP) and one in the Ambositra-Vondrozo corridor (COFAV) north of RNP. Morphometrics and molecular data (one mitochondrial/two nuclear loci) confirm *C. sibreei* was present at the high-elevation locality in RNP (n=9) and COFAV (n=10), sympatric with *C. crossleyi* (n=13). Only *C. crossleyi* was present in eastern slope rainforests (n=12). This is a range extension for *C. sibreei* of over 100km and the first record in a national park. RNP had few signs of human disturbance. The *C. sibreei* site in COFAV was used extensively for slash-and-burn agriculture, logging, and gold-mining. The COFAV and RNP have suitable habitat for relict populations of *C. sibreei*, but the COFAV is in need of conservation action. We were approved by SBU IACUC (2012-1959-NF-USDA-Lem) and Malagasy Ministry of Environment and supported by ASP, Rufford Small Grants, Explorer’s Club, NSF, PCI, SPZ, ISP, SBU, CI, and MBZ.

146. EFFECTS OF PRENATAL ENVIRONMENT ON REPRODUCTION IN CAPTIVE FEMALE GOLDEN LION TAMARINS (*LEONTOPITHECUS ROSALIA*) AND MARMOSETS (*CALLITHRIX SPP.*)

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In mammals that produce twins, the hormonal environment during gestation may differ according to littermate sex. We examined international studbook data on golden lion tamarins (*Leontopithecus rosalia*) (n=195) and laboratory records on marmosets (*Callithrix spp.*) (n=20), both twinning callitrichines, to examine the possible downstream effects of prenatal androgen exposure on female reproduction. We found that female lion tamarins gestated with only female co-twin(s) experienced significantly shorter latencies to first parturition after pairing with an unrelated adult male than did females that had gestated with one or more male co-twins (t=-2.1384, p=0.017). Conversely, gestational environment did not significantly affect this metric in female marmosets (t=-2.994, p=0.102). Secondly, sex-composition of the mother's gestational environment did not impact the mean number of fetuses produced per reproductive event for either species: the overwhelming majority of births in both species were to twins. Lastly, tamarin offspring born to multiparous mothers that had gestated with males experienced significantly higher survival to 730 days than those born to mothers that had gestated with females (Cox Proportional Hazards Model, p=0.05). Marmoset offspring survival was not affected by this variable. These results suggest that variation in the gestational environment may shape the life-history trajectory in *Leontopithecus* but not in *Callithrix*. Further inquiry is needed to elucidate the mechanisms contributing to distinctions between these and other callitrichine species.

147. AN ANALYSIS OF SELF-INJURIOUS BEHAVIOR IN A LARGE SAMPLE OF CAPTIVE PRIMATES

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Self-injurious behavior (SIB) is a serious behavioral problem that occurs in some captive primates. This study compiled information on SIB across 21,970 primates living at 7 National Primate Research Centers. Each facility used the "Self-injurious Behavior Scale" developed by the Behavioral Management Consortium to track individuals who expressed SIB. Overall, 0.7% (n = 159) of the subjects were reported to have wounded themselves during the one-year study period. The mean age of the SIB subjects was 7.7 years, 72% were males, 55% were mother-reared, and 64% lived alone during most of the study period. The mean number of wounds per subject was 3, 45% of the SIB subjects had only one incident of self-wounding, and 72% only had wounds meeting criteria for the mild category of SIB. Species differences were apparent with the prevalence of SIB varying from 0% to 3.7% across 9 species. Available records (n=113) showed 18% of the SIB subjects were treated with drug therapy. Chi-square analyses indicated no relationship between severity of the self-inflicted wounds and species, sex, rearing history, or social housing, but those undergoing drug therapy were more likely to have inflicted a severe wound (chi-square = 40.1, p<0.001). Enhancing our understanding of subjects that engage in SIB will be helpful in identifying those most at risk, and for preventing this problematic behavior.

148. POPULATION GENETIC STRUCTURE OF THE WHITE-FOOTED TAMARIN (*SAGUINUS LEUCOPUS*) AND IMPLICATIONS FOR CONSERVATION.

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Along with howler and capuchin monkeys, white-footed tamarins are the most smuggled primates in North-West Colombia. This is reflected by the large number of confiscated animals and releases into the wild, whose effect on the historical population genetic structure of the species is unknown. We thus aimed to assess natural levels of genetic variation and geographic genetic structure of *S. leucopus* across its entire range and determine the power of such information to infer the origin of smuggled animals. We sequenced 2,044bp of the mitochondrial DNA corresponding to the First Hypervariable Region (n=99) and the Cytochrome-b gene (n=79) in eight wild populations and captive animals. We also genotyped six nuclear microsatellites (n=85) in five populations and captive animals. Both mitochondrial and nuclear data revealed high levels of genetic variation. The network of mitochondrial sequences recovered two well differentiated haplogroups, one restricted to the northern distribution and another one containing central and southern populations. Likewise, captive individuals represented all the main haplogroups, suggesting illegal extraction from across the entire species geographical range. Elevated microsatellite differentiation within troops contrasts with high mitochondrial differentiation between troops, consistent with male-biased dispersal and matrilocality, a pattern also observed in other tamarins. These data have practical implications for identification of traffic routes, defining target populations for release actions, prioritization of regions for conservation and understanding the social structure of *S. leucopus*.

149. WESTERN LOWLAND GORILLA (*GORILLA GORILLA GORILLA*) BIRTH PATTERNS AND HUMAN PRESENCE IN ZOOLOGICAL SETTINGS

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There is evidence to suggest that zoo visitors can have a disruptive impact on zoo-housed animals, especially the great apes. While some consider Western lowland gorillas (*Gorilla gorilla gorilla*) to be particularly reactive to large crowds, the evidence of these effects is mixed, and is likely highly influenced by exhibit design and group composition. The effects of potential stressors such as human presence can be manifested in a number of ways, including the possibility of affecting the timing of births, as has been shown in laboratory-housed Callitrichids and chimpanzees. Unlike laboratories, where human presence is lowest during the weekends, we might expect human presences to peak during weekends in zoo settings, but in a study of zoo-housed chimpanzees, there were no significant differences between the number of chimpanzee births that occurred on weekdays vs. weekends (Wagner and Ross, 2008). We analyzed the timing of 359 gorilla births at accredited zoos from 1985-2012, and also found no effect of day of the week on number of births ($G=0.398$, $p=0.52$). These data add to our understanding of the

potential influence of human presence on primate behavior and physiology, and add to evidence suggesting that the effects of zoo visitors on exhibited species may be less deleterious than previously assumed.

150. MINIMIZING THE LIFETIME SEVERITY OF SELF-INJURIOUS BEHAVIOR IN AFFECTED RHESUS MACAQUES (*MACACA MULATTA*)

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Self-injurious behavior (SIB) can range from self-directed behavior that does not result in injury to self-wounding requiring humane euthanasia. SIB varies not only in its lifetime severity, but also in its initial presentation and lifetime trajectory. Among 409 rhesus macaques identified with SIB at the Tulane National Primate Research Center in the last decade, 149 initially presented with self-inflicted wounds and 260 presented with self-biting without wounds; 50 of these individuals later developing wounding. Preventing or at least forestalling such progression is essential for reducing the welfare impact of SIB for affected individuals, as well as SIB's impact on long-term research use. The proportion of self-biters that progressed to wounding was not influenced by rearing (nursery-reared: 22%; mother-reared: 18%) or sex (females: 20%; males: 19%). Housing history between initial presentation of self-biting and eventual wounding was compiled for progressors and a subset of non-progressors matched for age at presentation, sex, and rearing. Housing was categorized as predominantly single or predominantly social. There was a trend toward a larger proportion of the progressors having been housed singly prior to progression (54% vs. 34%; $X^2=3.5$, $p<0.06$). In addition, progression occurred after a mean of 367 days in animals housed predominantly singly and 727 days in those housed predominantly socially ($z=2.47$ $p<0.02$). While social housing may not be sufficient for preventing progression, it may be key to slowing it.

151. CONSERVATION OF MEXICAN PRIMATES BASED ON COMMUNITY PARTICIPATION

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The Mexican primates face threats related with the human presence because in many places they are sharing the geographic space. Deforestation, habitat decrease and hunting are the main threats that have been described. Our objective was to evaluate the opinion of local people about strategies of conservation before and after an informative workshop. We interviewed 499 people in 34 communities in protected and unprotected areas in Tabasco, Chiapas and Veracruz states. Questions were based on knowledge about biology, behavior, local perceptions, as well as benefits and interest in conservation of primates. During the workshop we informed about the importance of primates, and benefits of strategies of conservation such as live fences, reforestation, and other activities to promote conservation. We identify changes in perceptions and the main interest of people for participating in activities of conservation. After the workshop, 99% of people changed their opinion and believed it is important conserve primates and their habitat; 29% understood that they are dispersal agents; 47% accepted using live fences, and 53% accepted doing other activities to protect them; 82% of people believed that the best place to seed

native trees as live fences are the crop fields, because will let monkeys move between fragments. By knowing the opinion and interests of people in activities of conservation we can plan successful actions involving local people.

152. PARENTS FACE A QUANTITY QUALITY TRADEOFF OVER OFFSPRING REPRODUCTION AND LIFESPAN IN ICELAND

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Life history theory provides a framework for understanding how organisms allocate time, energy, and investment in an effort to maximize reproduction. Fast life history organisms prioritize faster growth and invest in fertility while slow life histories are characterized by slow growth and increased investment in survival. Because the resources are finite, the production of additional offspring necessarily dilutes the resources that parents have available to invest in all other offspring. Therefore, parents will presumably face a dilemma between investing in current offspring vs. investing in additional offspring or, rather, a tradeoff between producing more offspring and higher quality offspring. Although this strategic choice lies at the center of evolutionary biology, testing it in humans has been difficult, in large part due to the long generation time of our species. To solve this problem, this study utilized available data spanning approximately 300 years provided by an Icelandic genealogy. We report that with each additional full sibling, 1) an individual's average lifespan is reduced by almost one year, and 2) their lifetime reproductive success (LRS) is decreased by an average of .07 children. This phenomenon changes significantly over time in response to changing environmental conditions, so that poor environmental conditions exacerbate this trend. Our analysis provides a framework for understanding the ultimate evolutionary consequences of the conflict between the production of and investment in offspring.

153. EXTREME BEHAVIORAL PHENOTYPES, HYPOTHALAMIC-PITUITARY ADRENAL AXIS (HPA) ACTIVITY AND ANXIETY IN RHESUS MACAQUES (MACACA MULATTA)

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To examine the relationship between extreme phenotypes, stress reactivity, and anxiety in rhesus monkeys, we studied 41 (20 female) monkeys with self-injurious behavior (SIB) and 36 (19 female) age-matched controls at 3 large primate facilities. All monkeys were tested on the Human Intruder Test (HIT), and hair samples were obtained for determining chronic cortisol concentrations. Videotape scoring revealed a second group of 21 (10 female) hyperactive monkeys with locomotor stereotypy (LS), spread across SIB monkeys and controls. Hair cortisol concentrations did not differ among monkeys with SIB alone, LS alone, or controls (neither phenotype). However, monkeys with both phenotypes had significantly higher cortisol levels than the other groups ($F(3)=5.08$, $p<0.01$). This effect was only present in males ($F(3)=3.49$, $p=0.02$).

Monkeys with LS did not differ from non-LS monkeys in their reaction to the HIT. However, LS monkeys showed two distinct responses: suppressors that eliminated their LS in the presence of the intruder, and non-suppressors. Male suppressors had higher levels of cortisol ($F(2)=6.49$, $p<0.01$), and all suppressors showed higher threat responses during the stare phase compared to non-suppressors ($X^2(2)=7.81$, $p=0.02$). Suppressors also looked more in the direction of the intruder during the profile ($X^2(2)=5.86$, $p=0.05$) and stare ($X^2(2)=6.90$, $p=0.03$) phases. These results reveal a complex relationship between behavioral phenotypes and HPA activity in which pacing may serve to moderate the behavioral and physiological effects of stress in the non-suppressing animals. NIHGrant R24OD011180.

154. DEMOGRAPHIC AND EPIDEMIOLOGICAL ANALYSIS OF CAPTIVE CHIMPANZEES (*PAN TROGLODYTES*) FORMERLY USED IN BIOMEDICAL OR BEHAVIORAL RESEARCH

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The most recent demographic analysis of captive chimpanzees formerly used in biomedical or behavioral research (FBBR) examined a young population (mean age=15 yr) during a breeding phase. Today's population is aged (mean=28 yr), with a large geriatric (30+ yr) segment. Yet reliable demographic information is vital to rational population management and evidence-based veterinary practices for a long-lived species like chimpanzees. Demographic data on FBBR chimpanzees was compiled from multiple sources to update the demographic profile, quantify prevalent causes of death, and project population trends. There were a total of 1214 demographic records, with 338 mortality events. The estimated intrinsic rate of increase was -0.036, quantifying decline in a non-reproducing population. Population structure forecasting predicted that population size will decline 33% by 2025. The proportion of geriatric animals will increase from 32% to 80%. The top 3 causes of mortality were chronic diseases (cardiovascular, renal, cancer), displacing all infectious diseases. Results suggest a coming wave of chronic diseases. Long-term extrapolation predicted overall population extinction by 2057. Predicting the burden of morbidity associated with aging and other risk factors can facilitate advance planning and timely intervention. Continued monitoring of the changing demographics, morbidity profile and distribution of risk factors in FBBR chimpanzees is necessary to predict veterinary care and other resources that will be needed for the life-time care of increasingly geriatric chimpanzees.

155. FATHERS MEDIATE SOCIAL BONDS AMONG YOUNG OFFSPRING IN OLIVE BABOONS, *PAPIO HAMADRYAS ANUBIS*

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Although multi-male, multi-female cercopithecine societies are generally typified by promiscuous mating and male dispersal, reproduction is often skewed toward a few males, some of whom remain in the group with their offspring. Thus, fathers can interact with offspring through agonistic support, foraging, and protection from infanticide. This study explores how the development of social bonds among immatures is influenced by fathers. We studied juvenile olive

baboons (N=39) in one habituated group (n=111) in Kenya for 18 months. Behavioral data were gathered via 6,800 focal animal samples collected over 1,115 observation hours. Genetic relatedness was determined via noninvasive genotyping. Social bond strength was determined using the composite sociality index (CSI), which evaluates both the dyadic rate of grooming and frequency of proximity. Bonds were stronger among paternal half-sibs whose father was present in the group compared to those whose father was absent (present: N=9, absent: N=41; $B=-1.21$, $p<0.01$). Bonds among maternal half-siblings were stronger among those whose fathers were absent from the group than those whose fathers were present (present: N=10, absent: N=31, $B=2.4$, $p<0.001$). Finally, the bond strength of these paternal half-sibs was intermediate in strength between those of maternal half-sibs and of unrelated immatures only when shared fathers were present (Chi-square=17.6, $p<0.001$). These data suggest that not only do fathers facilitate the development of relationships among paternal half-siblings, but also those among maternal half-siblings.

156. RISK FACTORS FOR ALOPECIA AND HAIR CORTISOL IN RHESUS MACAQUES (*MACACA MULATTA*): FURTHER EVALUATION

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Alopecia is a complex condition impacted by natural, clinical, behavioral, and environmental factors. The purpose of this study was to further assess alopecia and hair cortisol in captive rhesus monkeys and identify potential risk factors, focusing on experiences that occurred during the prior year. Subjects were 142 rhesus monkeys (92 females), housed at three National Primate Research Centers. Photographs (left side, right side, back) and hair samples were obtained from the animals while they were sedated for routine physicals. Photographs were analyzed using Image J software to calculate total hair loss, and hair samples were assayed for cortisol. Hair cortisol was correlated with alopecia overall ($r(140)=0.277$, $p<0.005$), and at Facility 1 ($r(32)=0.559$, $p<0.005$). Linear regressions were conducted to assess the impact of intrinsic and environmental variables obtained from the animal records. For alopecia, age ($b=-0.061$, $p<0.001$), proportion of year singly housed ($b=-1.449$, $p<0.001$), and their interaction ($b=0.115$, $p<0.001$) were the only significant contributors to the model. Hair cortisol differed by facility and was higher for females ($b=13.263$, $p<0.005$) and animals receiving more sedations ($b=1.040$, $p<0.05$). The number of location changes was also a significant contributor to the model for Facility 1 ($b=8.977$, $p<0.01$). These results demonstrate that alopecia and hair cortisol can be affected by both intrinsic and environmental variables, but these results also vary by facility. Supported by grants R24OD01180-15, P51OD011133, P51OD010425, P51OD011092.

157. DEVELOPMENT OF A REMOTE GENETIC SAMPLING TECHNIQUE FOR THE AYE-AYE (*DAUBENTONIA MADAGASCARIENSIS*) USING ZOO LIVING INDIVIDUALS

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Despite advances in non-invasive genetic sampling over the last two decades, challenges in sampling elusive or unhabituated animals remain. We tested a method of non-invasive, remote sampling from feeding traces of two captive aye-eyes at Omaha's Henry Doorly Zoo and Aquarium (OHDZA). After we observed feeding traces on branches in the enclosure, branches were placed outdoors exposing them to temperature fluctuations, UV radiation, and precipitation. We removed pieces of exposed wood (<5g) from feeding traces using sterile razor blades, sampling daily for up to five days. We used e.Z.N.A® blood DNA mini-kits for extractions, aye-aye specific primers (AYE7 and AYE33) to amplify nuclear DNA, and gel electrophoresis to visually confirm presence of DNA. Samples were genotyped using Genemapper®. Of the 31 exposed samples, 16 yielded DNA (52%). We used χ^2 -test with William's correction for small sample sizes to test whether length of exposure affected the proportion of samples that yielded DNA; there was no significant difference across days ($p=0.29$). We detected different alleles at one locus from samples amplified using AYE33. This study confirms that it is possible to extract DNA from aye-aye feeding sites and to detect allele differences to distinguish between individuals. We will compare samples collected from aye-eyes in Madagascar to verify this method for use in natural conditions. This method holds much promise for sampling wild aye-eyes and other elusive primates.

158. GREAT APE MILK DIFFERS FROM HUMAN MILK IN NUTRITIONALLY SIGNIFICANT WAYS

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Great ape and human neonates are similar in many aspects of growth. A significant difference is the enhanced brain growth of human infants. Many scientists have proposed that human milk must have evolved a different composition to support brain growth. Brain growth is more energy/fat intensive and other lean body mass (LBM) is more protein intensive. Four gorillas and three orangutans at National Zoo and Zoo Atlanta have been trained to allow manual expression of breast milk, allowing longitudinal samples to be collected from soon after birth through several years of infancy. Based on 96 samples of lowland gorilla milk (*Gorilla gorilla*) and 28 samples of orangutan milk (*Pongo abelii* and *P. pygmaeus*), assayed at the Nutrition Laboratory of the National Zoo, great ape milk is lower in fat than human milk (gorilla milk fat = $2.5 \pm 0.1\%$; orangutan = $2.2 \pm 0.2\%$; human milk from literature = $3.7 \pm 0.1\%$; $p < .05$). Protein and sugar concentrations of gorilla, orangutan and human milks do not differ. Thus, energy density of great ape milk is lower than human milk (0.57 ± 0.01 kcal/g and 0.56 ± 0.01 kcal/g versus 0.67 ± 0.01 kcal/g; $p < .05$), and human infants receive a higher proportion of milk energy from fat. Gorilla milk contains 21.4 ± 0.4 mg of protein/kcal while human milk contains 16.2 ± 0.4 mg of protein/kcal, consistent with an emphasis on brain growth as opposed to other LBM growth in human neonates.

159. INCREASED VERTICAL CAGE SPACE AS A BEHAVIORAL THERAPY FOR LOCOMOTOR STEREOTYPY IN LABORATORY-HOUSED MACAQUES

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Locomotor stereotypy is a commonly reported abnormal behavior in captive-housed primates and may take various forms including pacing, back-flipping, and rocking. Increasing cage size and/or complexity has reportedly been met with varying levels of therapeutic success. The purpose of this study was to determine if providing laboratory-housed macaques with additional vertical cage space would reduce the proportion of time they engaged in locomotor stereotypy. The cage design allowed for the removal of half of the upper cage floor, thereby providing the animals with access to both the upper and lower level cages. Subjects were three male *Macaca nemestrina* (average age 3.6), three female *Macaca mulatta* (average age 5.1) and two male *Macaca mulatta* (average age 8.8). Animals were observed for an average of 78 days using an ABA (single cage, increased cage size, return to single cage) design and data were analyzed using a repeated measures ANOVA. Subjects showed a significant reduction in locomotor stereotypy when housed in a cage that allowed for additional vertical cage space ($F_{(2,14)} = 12.95$, $p = 0.001$) with stereotypic behavior returning to baseline levels when animals were returned to their standard single-cage housing. These data suggest that providing extra vertical space may provide an effective therapy for primates engaging in this type of abnormal behavior.

160. A LANDSCAPE GENETICS APPROACH DEMONSTRATES THE EFFECTS OF HUMAN DISTURBANCE ON THE UDZUNGWA RED COLOBUS MONKEY (*PROCOLOBUS GORDONORUM*)

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Understanding how human disturbance affects tropical forest ecosystems and the genetic structure of the species inhabiting those areas is critical for the mitigation of future losses in global biodiversity. We studied the endangered Udzungwa red colobus monkey (*Procolobus gordonorum*), which is endemic to the Udzungwa Mountains (Tanzania). This species thrives in large and well-protected blocks of old growth forest and it has been suggested that a healthy Udzungwa red colobus population will be indicative of a healthy rainforest ecosystem. The goal of our study was to understand whether or not distributions of genetic variation in the Udzungwa red colobus monkey have been affected by forest fragmentation, and if natural or human-related landscape features best explain genetic differentiation. We collected 170 fecal samples from 5 forest blocks and genotyped them using a panel of 10 microsatellite markers. We identified a total of 120 individuals. Traditional population genetic analyses identified two population clusters but

yielded ambiguous results as to the cause of genetic differentiation among Udzungwa red colobus populations. In contrast, landscape resistance models found that the combination of fire density on the landscape, distance to village, and resistance to cross railroads best explains the data. These results demonstrate the effects that human activities are having in an area of high global conservation priority and suggest that this ecosystem is in a precarious state.

161. FACE-TO-FACE INTERACTIONS INCREASE SOCIAL VIEWING PREFERENCES IN INFANT RHESUS MACAQUES (*MACACA MULATTA*)

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In both humans and rhesus macaques, mothers commonly engage in complex face-to-face exchanges with newborns, including mutual gaze and intense facial expressions. In the current study, we tested the effects of early social interactions on social viewing preferences in infant rhesus macaques. Infants were separated from their mothers on the day of birth and were randomly assigned to one of three groups: in the face-to-face group, human caregivers lipsmacked at infants in 5-min-long sessions, four times a day, from the first day of life until 28 days old (n=15). Infants in the extra-handling group were held for the same durations as the face-to-face group, but did not receive the face-to-face interactions (n=14). Infants in the standard rearing group did not see facial gestures and received no handling beyond standard nursery care and (non-related) experimental procedures (n=16). When infants were 40 days old, we presented them with side-by-side videos of a social and a non-social scene, and measured their visual preferences via a remote eye tracker. Results show that only infants in the face-to-face group looked significantly longer at the social scene compared to the non-social scene (t-test, alpha = 0.05, P=0.020 two-tailed). These results suggest that facial interactions have the potential to significantly affect infants' social-behavioral development, and that early intervention efforts might be highly effective in compensating for lack of early social interactions.

162. EFFICACY OF SUPPLEMENTAL ENRICHMENT IN REDUCING SELF-INJURIOUS AND SELF-BITING BEHAVIOR IN RHESUS MACAQUES

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Abnormal behaviors such as self-injurious behavior (SIB) and associated self-biting behavior, while relatively rare, represent important individual welfare concerns for laboratory and other captive nonhuman primates. Strategies such as social rearing/housing are key, yet other types of interventions are also frequently used when social housing is either not possible or ineffective. However, the efficacy of these alternative interventions for reducing these behaviors, known as supplemental enrichment (e.g. puzzle balls, shakers), is not always quantified. We therefore conducted an assessment of supplemental enrichment for reducing SIB and self-biting behavior in rhesus macaques. Behavioral data were collected monthly from individuals using 1/0 focal scan sampling from 2004-2014 for a total N=495 subjects. Dates of supplemental enrichment were noted by staff. Mixed-effects negative binomial regression was used with individual as the random effect. Model selection was used to choose models with the lowest AIC value; variables

with p values less than 0.05 were considered significant. Supplemental enrichment was effective for reducing self-biting in both single- and pair-housed animals during the period that supplemental enrichment was administered. Supplemental enrichment was not effective for reducing SIB. These results suggest that supplemental enrichment can be a useful strategy for reducing abnormal behaviors such as self-biting but not for SIB. Strategies for reducing SIB should therefore focus on proactive prevention rather than reactive intervention to reduce this behavior in captive primate populations.

164. TOOL SHARING BETWEEN CHIMPANZEE MOTHERS AND OFFSPRING AT GOMBE NATIONAL PARK, TANZANIA

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Chimpanzees (*Pan troglodytes spp*) at several study sites have been documented to show tool-assisted foraging of social insects. In particular, “termite-fishing” has been studied in detail at Gombe National Park, and sex differences in the developmental trajectory of the behavior have been well described. Less well known are the interactions that occur between youngsters (ages 0 to 10) and others in the context of sharing tools, which may provide evidence of social facilitation of skill learning. We reviewed an archive of 60 hours of termite-fishing video, and scored all instances (n=174) of an offspring (n=15) attempting to obtain a tool from another individual (usually the mother). Attempts were separated by whether the offspring used begging to request a tool or attempted to take the tool without a request. We found no difference in the percent of requests that were successful according to age or sex, suggesting that mothers were not adjusting their behavior relative to the expertise of the offspring. In addition, comparisons between these data and a comparably scored dataset from the Goualougo Triangle suggest significant differences in mothers’ willingness to share tools between sites. Successful requests for tools are three times more common at Goualougo than at Gombe. Such detailed analyses and intersite comparisons are critically important to our understanding of social learning and behavioral diversity in the wild.

165. DEVELOPMENT OF ABNORMAL BEHAVIOR IN NURSERY-REARED RHESUS MACAQUES (*MACACA MULATTA*): COMPARING REARING STRATEGIES

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Strategies to mitigate the development of abnormal behavior in nursery-reared monkeys include refinement of existing rearing procedures. We examined the development of abnormal behavior in three different nurseries at Yerkes. In comparison to the standard nursery (SN, n=48) subjects, alternate nursery 1 (AN1, n=9) subjects were reared with more human handling and earlier conspecific social contact; alternate nursery 2 (AN2, n=8) subjects experienced earlier social contact and rotational pair housing, and were provided semi-mobile artificial surrogates. The presence or absence of abnormal behaviors was recorded during at least three observations per week from arrival in the nursery until six months of age. Data were analyzed to determine whether the different rearing techniques influenced the prevalence of abnormal behaviors. At age

six months, 32% of the subjects had exhibited at least one abnormal behavior. The most common abnormal behaviors were self-directed stereotypies (29%), such as rocking and self-clasping, and floating limb (11%). A significantly greater percentage of monkeys in the SN developed abnormal behaviors (44%) as compared with the other two nurseries (AN1=0%, AN2=13%) (chi square (2) = 8.34, $p=0.015$). Results will be used to further improve nursery rearing practices to minimize the emergence of abnormal behavior. Since abnormal behaviors are difficult to treat after initial onset, prevention of their development by refining management practices is desirable.

166. MATERNAL CARE QUALITY PREDICTS EARLY INFLAMMATION AND DISEASE RISK IN RHESUS MACAQUES

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Poor quality parental care predicts adverse health problems such as metabolic, inflammatory and cardiovascular disease. In a long-term developmental study in rhesus macaques (*Macaca mulatta*), we examined the impact of maternal care quality on early inflammation and risk for inflammatory disease in adulthood. Mother-infant (N=155 pairs) interactions were observed three to five times weekly in large outdoor social enclosures at the California National Primate Research Center. Mother-infant interactions were recorded using six themes (protective, affiliative, accommodating, neutral, rejecting, and aggressive). Maternal care scores were generated by subtracting rate of maternal aggressiveness from rate of protectiveness. At 3-4 months of age, plasma samples were collected from infants during a standardized biobehavioral assessment. Plasma concentrations of pro-inflammatory proteins (IL-6, IL-8, MCP-1, CRP, and TNF α) were quantified. Infants that received lower care exhibited greater inflammation (Pearson correlation; $r=.185$, $p=.03$). In a subset of infants that reached 36 months of age ($n=64$), presence of disease of inflammation (eg, colitis, arthritis) was investigated. Individuals that received low care (one tailed t-test, $t=1.714$, $p=.045$) and which had higher cytokine concentrations (one tailed t-test, $t=1.711$, $p=.045$) were more likely to develop diseases of inflammation. These results suggest that early maternal care programs a pro-inflammatory phenotype, putting infants at risk for disease later in life.

167. EXPRESSION OF ABNORMAL BEHAVIOR IN NURSERY-REARED SOOTY MANGABEYS (*CERCOCEBUS ATYS*)

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Research shows that nursery-rearing puts captive primates at risk for developing abnormal behavior (AB). We evaluated an intervention program of (re)introducing abandoned, orphaned, or C-section-delivered infants to their biological or surrogate dam, with subsequent integration into social groups. We expected the increased complexity of the social environment early in life to mitigate development of AB. Nine juveniles experienced this program (0.9-3.5 years) and were assessed for the presence and forms of AB over a nine-month period using 5-minute focal animal sampling, three times weekly. We compared these juveniles with two groups of nursery-reared adults (7.5-26.5 years) that were assessed using the same methods but did not go through the intervention program one group living in social-housing (N=8) and another in single-housing (N=8). Using Fisher's exact tests, we compared the proportion of subjects in each group that

exhibited AB. Significantly fewer juveniles than adults displayed any form of AB ($p=0.01$): four of nine juveniles, seven of eight socially-housed adults ($p=0.08$), and eight of eight singly-housed adults ($p=0.02$). Comparing juveniles that displayed AB with those that did not provided preliminary evidence that risk for AB development increases with duration of single-housing, age when (re)introduced to the dam was complete, and amount of human handling in the nursery. These results suggest that the intervention program may help to reduce the risk of AB development in mangabeys.

168. BUILDING CONSERVATION LEADERSHIP IN HABITAT COUNTRIES—A CONTINUING CONVERSATION

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We began a discussion on building conservation leadership at the 2014 IPS Congress in Hanoi, Vietnam through a presentation by a panel of 10 primatologists with experience in a broad array of habitat countries, including Brazil, China, Indonesia, Madagascar, Morocco, Peru, Suriname, and Vietnam. Presenters agreed that an important element of conservation practice is building in-country leadership and that given the deep anthropogenic impacts on primate habitats, conservation measures should be incorporated in every research program. Discussion between panel and audience participants raised a number of important suggestions and questions, including: 1) How can field primatologists best integrate research goals and capacity-building where they work? 2) How might primatologists create effective networks with local stakeholders to enhance the impact of training in habitat countries? 3) Can a network of collaborators develop methods to bridge unique characteristics of local communities? and 4) Could the development of “conservation training standards” using techniques such as “teaching-to-teach” extend the breadth and duration of knowledge and impact? In this round-table, we plan to address these questions through guided discussion, widen the conversation to include additional primatologists, and develop social media and other mechanisms to enhance communication among researchers. Ultimately, we aspire to develop a common set of recommendations and guidelines, ideally distributed to ASP members, which encourage and support primatologists in developing conservation leadership efforts.

169. SEROTONIN TRANSPORTER AND MATERNAL CARE: A SEX-SPECIFIC G X E EFFECT ON JUVENILE SOCIAL PLAY IN FREE-RANGING RHESUS MACAQUES OF CAYO SANTIAGO

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Individuals carrying a shortened (S) allele in the promoter region of the serotonin transporter gene (5HTLLPR) display depressive or anxious phenotypes following early social adversity. However, because both human and macaque populations have persistent S alleles, the common psychiatric interpretation that the S allele is universally pathogenic seems unlikely. We

hypothesize that S alleles are maintained under stabilizing selection from Gene x Environment (GxE) interactions which are adaptive in particular environments. Here we tested the prediction that a GxE interaction between 5HTLLPR genotypes and maternal care benefits S carriers in terms of social competence measured by play behavior. Subjects were N=42 free-ranging rhesus macaque (*Macaca mulatta*) offspring on Cayo Santiago, PR. We recorded mother-infant interactions during the first 12 weeks of infant life, genotyped the offspring, and recorded juvenile play behavior between 16-24 months of age. Maternal care interacted with 5HTLLPR genotypes and offspring sex, such that compared to lengthened allele (LL) homozygotes of all maternal types, male S allele carriers who received more maternal care subsequently displayed more social play (Wald Chi-Square = 16.09; $P < 0.0001$), and male S allele carriers that received less maternal care displayed less social play (Wald Chi-Square = 18.71; $P < 0.0001$). The S allele is thus not universally deleterious, but confers elevated social competence to male offspring provided high amounts of maternal care.

170. A REVIEW OF DRUG THERAPIES FOR SELF-INJURIOUS BEHAVIOR

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The list of drugs used to treat self-injurious behavior (SIB) in nonhuman primates (NHP) is growing, and both the importance and difficulty of keeping abreast of new information grows with it. Where the perception exists that information about therapies is unclear or ambivalent, practitioners may fall back on using outdated therapies with which they are most familiar even in cases where a better option is available. This presentation will attempt to clarify and summarize the available information about several drugs commonly used in the treatment of SIB. Benzodiazepines are one of the most commonly used classes of drugs owing to their low cost and long history of use, but may exacerbate some cases SIB, and the side-effects of withdrawal often “trap” clinicians into chronic treatment with drugs that might best be used to counteract transient anxiety. Treatments targeting serotonin signaling in the brain, such as tryptophan and selective serotonin reuptake inhibitors, have prolonged times-to-effect but more consistent support in both therapeutic and mechanistic literature. “Newer” treatments targeting other systems, such as guanfacine and extended release naltrexone, are more expensive and have less collective experience using them, but offer viable alternatives when first line treatments fail. The efficacy of these and other pharmaceutical therapies for SIB will be discussed along with features relevant to their practical use, such as dosing, cost, and pharmacokinetics.

171. BEHAVIORAL COMPARISON OF MOTHER- AND NURSERY-REARED PIGTAILED MACAQUE (*MACACA NEMESTRINA*) FEMALES HOUSED SOCIALLY IN LARGE INDOOR/OUTDOOR ENCLOSURES

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Nursery rearing of nonhuman primates (NHPs) has been associated with increased risk for developing abnormal behaviors. However, most studies have been undertaken in nursery-reared animals maintained in a laboratory environment for most or all of their lives. This study investigated behavior of 14 nursery-reared and 14 age-matched mother-reared female pigtailed

macaques (2.5-5.5 years of age) maintained in social groups at the WaNPRC Arizona breeding facility. Animals were housed in large connected indoor (216 sf)/outdoor (242-400 sf) enclosures and were fed twice a day (morning and afternoon). Daily food or destructible enrichment was also provided. Twenty three hours of data were collected using The Observer XT software. Data were analyzed using a paired T test. Rates of behavior were remarkably similar between the two groups. The only significant differences arose in appetitive behaviors. Nursery-reared animals spent more time eating ($p=0.03$) and drinking ($p=0.01$) despite the fact that there were no differences in weight between the two groups. Differences in rates of stereotypic behaviors approached significance ($p=0.059$) although proportions of time nursery-reared animals engaged in this behavior was extremely low (3.3%). These data suggest that NR females exhibit relatively normal behavioral repertoires when housed in non-laboratory conditions. They also suggest that subtle metabolic differences may exist between these two groups. Funded by NIH grants P51 OD010425 and R24OD01180-15

172. AFFILIATION, TOLERANCE AND PROXIMITY BETWEEN MALES AND INFANTS IN WILD *COLOBUS VELLEROSUS* IN GHANA IS NOT EXPLAINED BY GENETIC SIRESHIP

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Infanticide is only a successful male reproductive strategy if males do not kill their own offspring, resulting in a conflict of interest with females over the disclosure of paternity information to males. Females should mate polyandrously to dilute paternity certainty among potentially infanticidal males. In contrast, males would benefit by developing accurate skills to distinguish their own offspring. We reported elsewhere that potential sires, defined as sexually mature males present in a group at the time of an infant's conception, were affiliative with and tolerant of that infant more than newly immigrated unlikely sires. Here, we continue this investigation by asking if males accurately biased affiliation toward offspring. We collected focal data on 8 immigrant males (26 male-infant dyads) over 6 months from 4 groups of wild *Colobus vellerosus* in Ghana, a species where infanticide occurs and females mate polyandrously. We genotyped 10 STR loci to confirm paternity for 12 infants that interacted with focal males. We compared the rate of affiliation, male tolerance of infants, and time spent in proximity for sire-infant dyads (N=7) and non-sire-infant dyads (N=19) using three GLMMs where infant availability was a covariate. Paternity did not predict patterns of affiliation ($F_{(1,23)}=1.876$, $p=0.184$), tolerance ($F_{(1,23)}=2.151$, $p=0.156$) or proximity ($F_{(1,23)}=0.630$, $p=0.435$). Therefore, males do not consistently discriminate between potential and actual offspring and polyandrous mating may be successfully confusing paternity among males.

174. SOCIAL ENVIRONMENT PREDICTS TEMPERAMENT OF INFANT RHESUS MACAQUES (*MACACA MULATTA*)

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Research shows that infant temperament is related to childhood, adolescent, and to some extent, adult social competence. Because infant temperament is thought to be the foundation for personality and competent functioning, it is important to understand factors modulating the development of infant temperament. Data was collected using a biobehavioral assessment developed at the California National Primate Research Center to measure behavior and temperament for infant rhesus macaques (*Macaca mulatta*). Infants were scored on 16 temperamental traits, which were incorporated into four temperament scales derived through factor analysis to assess for human-like traits: confidence, gentleness, nervousness, and vigilance. Our goal was to measure whether infant temperament is modulated by variation in social environments (measured by variation in home cage settings). Subjects were reared in one of 22 large open field cages that houses 100 to 150 rhesus monkeys, and approximates the natural setting for rhesus monkeys. We hypothesized that infants would display temperaments that varied according to the field-cage in which they were reared. ANOVA showed that the cage social environment was significantly related to infant temperament across each of the temperamental traits measured ($p < 0.0009$, $p < 0.0009$, $p < 0.0009$, $p < 0.001$). While genetic influences cannot be ruled out, our findings suggest that the social environment influences temperament and likely predicts future behavior.

175. SUPPLY-AND-DEMAND OR SOCIAL INVESTMENT? CONTEST COMPETITION AND GROOMING EXCHANGE AMONG FREE-RANGING RHESUS MACAQUES

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In nonhuman primates, (allo)grooming is frequently exchanged either reciprocally for itself or interchangeably for access to rank- or fitness-related benefits (infant-handling, feeding/drinking-tolerance) to varying degrees. One explanatory framework for such variation combines socio-ecological and biological-markets principles: reciprocity prevails when the costs of within-group resource competition (WGC) are low, and interchange prevails when high WGC-costs generate a strong demand for rank-related benefits. We examined evidence for this dynamic among free-ranging rhesus macaques (*Macaca mulatta*) on Cayo Santiago. Data on agonistic, affiliative, and contest-competitive behavior were collected on adult females (n=30) of group S using focal-animal and all-occurrences sampling. Rowwise matrix correlations showed both significant grooming reciprocity (Kendall's T=0.42, $p < 0.001$) and interchange for receiving drinking-tolerance (Kendall's T=0.26, $p = 0.005$). GLMs showed moderate evidence for positive relationships between WGC-costs (feeding on scattered, low-quality food: $B = 0.567$, $p = 0.02$) and interchange, but not when controlling reciprocity ($B = -0.085$, $p = 0.72$). Jointly modeling grooming and drinking-tolerance social networks showed that greater-than-expected numbers of grooming dyads also codrank, but independently of direction ($\chi^2(9) = 25.03$, $p < 0.005$). Our findings point to social-investment rather than biological-markets: when WGC-costs are high, macaques with strong grooming relationships also tend to cooperate or tolerate each other more when drinking, but without keeping track of exact transactions (who owes whom).

176. PAPIO ANUBIS SEED DISPERSAL PRELIMINARY RESULTS: FEWER SEEDS DISAPPEAR IN LOGGED COMPARTMENT THAN UNLOGGED IN KIBALE NATIONAL PARK, UGANDA

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In Kibale National Park, Uganda, olive baboons (*Papio anubis*) are eclectic omnivores, with very large home ranges comprising a diversity of habitat types and forest compartments with different logging histories. Baboons thus have the potential to disperse many seed species into multiple locations, some of which may be more favorable for seed fate. We followed a habituated group of olive baboons (June-July 2014) in Kibale's Kanyawara study area to investigate their seed rain into logged and unlogged forest. Eighty-three dung samples were collected opportunistically, and 1131 seeds were removed from 10 random dung samples. Fifty-meter transects were established in two forestry compartments with different logging histories: 3 in logged forest (K-15) and 3 in unlogged (K-30). Using the three most common seed species, 5 seeds of either *Solanum* spp (n=81), grass spp (n=67) or *Aframomum* spp (n=30) were randomly placed at seed stations every 10m along the transects (n=90 seeds unlogged, n=88 seeds logged) and monitored for seed damage and disappearance. We recorded the proportion of whole seeds remaining for each seed station and determined K-15 versus K-30 averages. We compared these averages using paired, two-tailed t-tests. The average proportion of seeds remaining in the unlogged area was significantly lower than the logged area (p<0.01; t=4.6586). This has potential implications for the role of olive baboons in forest regeneration in Kibale National Park.

177. ESTABLISHING A BEHAVIORAL MANAGEMENT PROGRAM FOR GERIATRIC CHIMPANZEES

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In order to ensure the comfort, health, and wellbeing of geriatric chimpanzees in captivity, a formal system of management is essential. Twenty-eight percent of the chimpanzees at the Michale E. Keeling Center for Comparative Medicine and Research are considered geriatric, defined as 30 years of age and older. In order to appropriately care for this aging population, we are developing a 'geriatric management program' utilizing a behavioral management approach that focuses on individualized, cage-side care. This program has a number of facets, not unlike programs used at retirement or nursing facilities for aging humans. Components of the geriatric management program include: 1) environmental modifications that allow for easier movement; 2) daily health monitoring utilizing positive reinforcement training techniques to elicit voluntary participation in medical behaviors (i.e. auscultation, blood pressure monitoring, venipuncture); 3) dietary modifications to address the caloric requirements of aging and mobility-impaired animals; and 4) physical therapy in the form of either enrichment and feeding devices or training techniques that require animals to complete desired movements to obtain food. Baseline assessments of cognitive ability, mobility, and weight are collected on the whole colony to provide comparative data as animals age. This program provides specific, yet flexible (depending on each individual animal's needs), guidelines for staff to follow to maintain and monitor maturing animals in ways that promote healthy aging.

178. GETTING INVOLVED IN ENRICHMENT: THE STYLE OF CARETAKER-PRIMATE INTERACTION AND RESPONSE OF LABORATORY RHESUS MACAQUES (*MACACA MULATTA*).

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The way caretakers interact with nonhuman primates can be a crucial aspect of a behavioral management program. Indeed, there is growing evidence that positive human interaction (PHI) and positive reinforcement training (PRT) can promote behavioral health and the psychological well-being of nonhuman primates. The extent to which a given program utilizes PHI may vary between facilities, but we were afforded the rare opportunity to compare and contrast three styles during a recent merger and transition period. While many aspects of the housing and behavioral management program were analogous across facilities, the carestaff stability and involvement with enrichment varied. Caretaker interaction styles varied from 1) rotating caretakers / minimal PHI, 2) stable caretaker / minimal PHI, and 3) stable caretaker / regular PHI. Matched groups of rhesus macaques (*Macaca mulatta*) were selected from each facility based on age group and sex, and individual temperaments were separately scored by familiar and unfamiliar observers. Preliminary results indicate a lower (less aggressive) temperament reaction in the Treatment3 (stable caretaker / regular PHI) setting when compared to the other conditions (ANOVA, ntotal=297, $\eta^2=0.05$, $p<0.0032$). The ongoing study seeks to identify which style of caretaker involvement promotes animal's receptivity to humans. Investigating the role of carestaff and other non-enrichment personnel in ongoing environmental enrichment programs enables facilities to refine behavioral management procedures and promote facility wide investments in animal welfare.

179. ASSOCIATIONS BETWEEN DIET, GUT MICROBIAL COMMUNITIES, AND HEALTH IN RED-SHANKED DOUCS (*PYGATHRIX NEMAEUS*): A MODEL FOR THE SUBFAMILY COLOBINAE

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Red-shanked doucs (*Pygathrix nemaeus*) and other colobines possess specialized gastrointestinal systems similar to ruminants. They utilize both fore- and hindgut fermentation to meet their energetic demands. Maintenance of captive populations has been largely unsuccessful. Improving captive conditions is hindered by critical gaps in our understanding of their natural diet and enteric microbial adaptations that facilitate the digestive process. We used the douc as a model to study the relationships between diet and microbial community activity within the

gastrointestinal tract. Fecal samples from 7 wild and 27 captive red-shanked doucs were collected between 2012-2013 from Son Tra NR (Vietnam) and 3 captive facilities. We measured gut microbiome composition using 16S rRNA sequencing. PICRUSt software was used to predict microbial function. Feeding behaviors of wild doucs were surveyed using focal sampling. Foraged plant species were collected and analyzed for nutrient content. Dietary records, including nutritional data, were provided by the captive facilities. Statistical analyses were performed to identify correlations between diet, gut microbiome, and animal status (captive vs. wild). Analysis of similarity revealed that gut microbial communities grouped by animal status (ANOSIM $R = 0.92$; $p = 0.001$). A reduction in gut microbiome richness and diversity was observed in captive doucs. We identified microbial biomarkers of douc nutritional health. We hypothesize that captivity causes doucs to shift to severe gut dysbiosis, thereby resulting in GI issues.

180. DEVELOPMENTAL CHANGES IN SOCIAL ATTENTION IN INFANT MACAQUES (*MACACA MULATTA*)

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From birth, human infants undergo several critical periods in their development of social attention, including experience-dependent changes in attention to faces. Less is known about whether infant monkeys share similar developmental changes. We tracked longitudinally the visual attention of twenty infant monkeys in 2013 (N=10) and 2014 (N=10) using eye-tracking. Fourteen testing sessions were conducted between the first and 23 weeks of life. For this study, we report the infants' attention when viewing videos of unfamiliar female rhesus macaques and their young infants. The percentage of total viewing was analyzed using hierarchical linear modelling where age was a random effect and region of interest (mom vs infant's face and body) was the dependent variable. The 2013 cohort showed a significant linear interaction between age and region of interest, $F_{(1,128)} = 6.73$, $p < 0.01$. From the first week of life, infants preferred to look at the infant's vs female's face (34% vs 23%), but this decreased over time to 7% in week 23, while attention to the female's face increased to 31% of the total viewing time. The switch in preference occurred after week 7. No differences were found in time spent viewing bodies, or nonsocial video content. These results demonstrate experience-dependent changes in infant monkeys' attention to faces over the first few months of life that is similar to patterns found in human infants.

181. EARLY SOCIAL ENVIRONMENT AND SEX ARE ASSOCIATED WITH WHITE MATTER ASYMMETRIES IN THE FRONTO-INSULAR CORTEX OF CHIMPANZEES (*PAN TROGLODYTES*)

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The insula, a lobe of the cerebral cortex, participates in various integrative perceptual and cognitive processes as part of the salience network. Von Economo neurons (VENs), a derived class of spindle-shaped projection neurons implicated in self-awareness and social cognition, are found in the fronto-insular (FI) cortex of humans and great apes. Here, we quantified white matter connections between FI and the entire cortex in order to understand its role in the salience

network. We calculated volumes of FI white matter connections in vivo using diffusion tensor imaging (DTI) in 49 chimpanzees (*Pan troglodytes*) (males: n=20, females: n=29). We defined FI based on probabilistic mapping of its location from cytoarchitectural identification of VEN distribution in 11 post-mortem brains. Our results indicate connections between FI and regions comprising the salience and social cognition circuits (e.g. medial and superior temporal gyri, prefrontal cortex, and frontal pole). Additionally, we performed mixed-model ANOVAs to examine sex and rearing effects on volumes of FI connections (mother-reared: n=19; human-reared: n=30). Males show greater volumes of white matter connections in the left hemisphere compared to females ($F_{(1,45)}=4.891$; $p=0.032$). We also found that human-reared individuals display rightward asymmetries ($F_{(1,45)}=5.247$; $p=0.027$) while mother-reared chimpanzees showed the opposite pattern. These results highlight the impact of early social experience on cortical white matter development.

182. BEHAVIORAL FLEXIBILITY IN CAPTIVE CHIMPANZEES (*PAN TROGLODYTES*): BUILDING ON AN ESTABLISHED FORAGING TECHNIQUE TO IMPROVE EFFICIENCY

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Whilst the evidence for culture in non-human species continues to grow, there are few examples of cumulative culture outside of our own uniquely complex behaviors. The prerequisites for cumulative culture include not only the ability to build on established behaviors but also to relinquish old behaviors and flexibly switch to more productive or efficient ones. Here we established an inefficient solution to a foraging task in four captive chimpanzee groups (n = 16). Two groups were subsequently seeded with a conspecific model who demonstrated an alternative, more efficient, solution to the same task. When participants could still successfully forage with their previously established behaviors, individuals did not switch to this more efficient alternative; however, when their foraging method eventually became highly inefficient relative to that of the available alternative, seven chimpanzees with socially-acquired information (three of whom were exposed to additional human demonstrations) relinquished their old behaviors in favor of the more efficient alternative. In contrast, only one individual in the control groups was seen to do this ($W = 54.5$, $p < .001$, $r = .67$). Individuals who switched were later able to combine behavioral components of these two techniques. Our results show that chimpanzees possess some behavioral flexibility, are able to build on behaviors and can use multiple solutions to solve the same problem, indicating greater potential for cumulative culture than previously thought.

183. ASSESSING STRESS IN WESTERN LOWLAND GORILLAS (*GORILLA GORILLA GORILLA*) IN HUMAN CARE USING ALLOSTATIC LOAD

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Lifetime stress contributes to humans and nonhuman primates (NHP) developing chronic degenerative diseases. Allostatic load (AL) in humans measures cumulative stress and predicts future health outcomes. AL incorporates multiple biomarkers to determine a composite score reflecting current and future health. We propose AL will identify potential drivers of compromised health and thereby decreased longevity among NHP. We obtained data from gorillas (n=27) housed at the Columbus Zoo and Aquarium between 1956 and 2014. As in humans, AL was predicted to associate with age, lifetime stress events, and age at death, while having a negative relationship with general health. Biomarker values were obtained noninvasively using medical records and banked serum assays. Stress events (defined as agonistic interactions with wounding, zoo transfers, and immobilizations) were transcribed from keeper records. We developed four exploratory iterations using linear regressions and propose Model 4 AL best identifies stress events and best predicts future outcomes in this sample. At $\alpha=0.05$, sex ($p<0.006$) and stress events ($p=0.040$) significantly associate with AL in our sample, while age approaches significance ($p=0.054$). Using cholesterol, triglycerides, and creatinine as general indicators of health, AL significantly associates with creatinine ($p=0.042$) and triglycerides ($p=0.041$), and approaches significance for cholesterol ($p=0.077$). AL and age at death are not associated (n=11, $p=0.169$). This research develops a possible path for better understanding long-term consequences of stress on NHP health.

184. LESSONS LEARNED FROM CAPTIVE LORISES: OPPORTUNITIES FOR LINKING CAPTIVE POPULATIONS TO CONSERVATION PROGRAMS IN SOUTHEAST ASIA

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In North America, lorises have been kept in zoos, primate centers and as pets for over 127 years. We analyzed historical records of 791 slow and pygmy lorises (*Nycticebus* sp.) to determine population trends throughout their captive history. Increases and declines were influenced by different historical levels of understanding of loris biology, taxonomy and husbandry. Captive management priorities also changed in response to an increased awareness of conservation challenges in the wild. We looked at information gathered on these captive lorises including genetic, behavioral and reproductive research along with breeding programs aiming at the preservation of genetic diversity. We then considered the conservation situation for *Nycticebus* in Southeast Asia. All loris taxa are classified as “Endangered” and populations in the wild are rapidly declining. During the past fifteen years, an increasing number of rescue centers and reintroduction programs for lorises are trying to target the problems faced by the wild populations in the source countries. However, rescue centers are often not in a position to conduct in-depth research. Loris ecology is still comparatively poorly known making successful reintroduction very difficult. We suggest using part of the current captive population in North America to once again establish a research and breeding colony to study loris ecology and maintain direct links with field conservation projects, thus contributing more effectively to loris conservation in the wild.

185. LEADERSHIP IN THE COLLECTIVE MOVEMENTS OF TIBETAN MACAQUES (*MACACA THIBETANA*) AT MT. HUANGSHAN, CHINA

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As a socially well-connected and cohesive species, humans tend to make many collective decisions. How do nonhuman species collectively relay information? We present data on the leadership of collective movements in Tibetan macaques (*Macaca thibetana*) in Mt. Huangshan, China by analyzing their movements in relation to their social networks. All-occurrence sampling was used to investigate collective movement patterns, and focal and scan sampling were used to retrieve information on their affiliative and agonistic behaviors for a complete social network analysis. There were a total of 128 successful collective movements recorded over a two-month period. All 20 adult individuals participated in collective movement leadership. There was no significant effect of sex, age or rank on the leadership frequency of adult troop members. However, the highest-ranking female (YH) and a young female (TXX) significantly led more collective movements than expected by chance. The strength and eigenvector centrality of affiliative and agonistic social networks were significantly correlated with collective movement. Both females belong to different clusters in the social network analysis of collective movement, meaning that certain individuals tend to move with one female or the other. Individuals belonging to these two clusters may be a consequence of the mating season. An alpha level of .05 was used for all statistical tests. Supported by NSFC (30970414 & 31172106) and NSF-OISE (1065589).

186. A NEW TEST OF EXECUTIVE FUNCTION FOR NONHUMAN PRIMATES

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Phenotypic tools to assess aging have been translated into a comprehensive testing system for marmosets. Development of a test to assess executive function, control of execution and planning, has proven to be difficult. A task to assess visual motor control allows the subjects to retrieve a reward from a conveyor belt. Several tasks exist including random presentation from each side of the belt, continuous presentation, reduced time frame, and alternating presentation. We developed a new task in which the subjects are asked to control the impulse to retrieve an unpreferred treat (apple) in order to wait for the preferred treat (marshmallow). The subject cannot retrieve both samples and if they retrieve the apple they cannot retrieve the preferred treat. Five geriatric subjects (G) and seven young subjects (Y) were tested on each task with 50 trials per session. Average success for subjects varied slightly during each task: alternating task (G=90.8+2.03, Y=81+2.57), reduced time (G=79+5.3; Y=72.5+5.4); continuous direction (G=87.2+2.2, Y=81.1+2.4); and random presentation (G=86.6+2.1, Y=84+2.8). The executive function task resulted in lower average success for both the geriatric and the young animals, although the geriatrics performed better (G=64+10.2, Y=42.8+9.6). Interestingly the failure of young animals was due to inability to control impulse (apple success G=16+7.3, Y=40+9.6). We believe this task may be a novel way to assess executive function in nonhuman primates.

187. THE EFFECT OF TESTOSTERONE ON ATTENTION AND ANXIETY IN ADULT MALE RHESUS MACAQUES (*MACACA MULATTA*)

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Research in humans and macaques indicates that testosterone reduces anxiety elicited by negative social stimuli. Initial research assessing emotional state in nonhuman primates with attention bias testing suggests that those in a negative state attend longer to negative stimuli. We assessed emotional state in response to stimuli using an attention bias paradigm with six surgically castrated and six intact male rhesus macaques. We presented subjects with either a positive photo (e.g., food) or a negative photo (e.g., threat face) paired with a neutral photo for 20 seconds and video-recorded their responses. Subjects were shown eight positive/neutral and eight negative/neutral photo pairs. We hypothesized that castrated males would attend longer to negative stimuli and display more anxiety than intact males. Using GLMM regression with Poisson distribution and AIC model ranking we compared time spent looking at photos and frequency of anxiety behaviors between castrated and intact males. Contrary to expectations, castrated males looked at all photo types equally, whereas intact males looked at negative photos longer than neutral or positive photos ($B(\text{neutral}) = -0.85, p < 0.001$; $B(\text{positive}) = -0.90, p < 0.001$). Additionally, castrated males showed less anxiety ($B = -1.01, p < 0.001$). Testosterone was not associated with decreased anxiety in this study. However, our results are consistent with the hypothesis that testosterone reduces avoidance of negative social stimuli. More work is needed to understand the relationships between testosterone, anxiety, and attention to negative stimuli.

188. BIOBEHAVIORAL CONSEQUENCES FOR INFANT RHESUS MONKEYS (*MACACA MULATTA*) OF PRENATAL EXPOSURE TO A MATRILINEAL OVERTHROW AND RELOCATION

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Differential postnatal experiences can result in significant phenotypic variability in rhesus macaques; however, relatively little is known about the influence of prenatal experience on infant postnatal phenotype. We investigated infant behavior and physiology in infant rhesus macaques that had been conceived in outdoor field cages, but owing to a matrilineal overthrow, had been relocated in utero to an indoor housing facility. Our prediction was that the presumed stress of the overthrow and relocation of pregnant females would alter the behavior and physiology of their infants. We compared prenatally-relocated infants born to mothers relocated in the first trimester ($N=13$) and second trimester ($N=7$) to three age-matched control groups: infants born to the same mothers in a different year ($N=12$), infants born in a comparable field cage in the same year ($N=23$), and infants that were gestated and reared indoors ($N=13$). One-way ANOVA found second trimester-relocated infants had elevated cortisol ($F(1,18) = 4.73, p = 0.043$) and lower activity levels ($F(1,18) = 5.42, p = 0.032$) compared to first trimester-relocated infants. One-way ANOVA and planned comparisons suggested second trimester-relocated infants had elevated plasma cortisol levels ($t(77) = 2.517, p = 0.010$), lower lymphocyte count ($t(76) = -2.97, p = 0.013$), and were more emotionally reactive ($t(79) = 3.089, p = 0.001$) than infants born to field-

caged mothers. Our results add to a growing body of literature that suggests prenatal experience can shape infant behavior and physiology.

189. TESTOSTERONE AFFECTS TRAINING SUCCESS IN MALE RHESUS MACAQUES

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While a great deal of emphasis has been placed on the effects of estrogen on mood and cognition, less is known about the role of testosterone. Studies examining testosterone on cognitive function have had mixed results. We examined whether testosterone affected trainability in 11 adult, male rhesus macaques (*Macaca mulatta*). Five monkeys were castrated and the other six underwent a sham castration surgery, and all were on a high fat diet as part of an unrelated study. Approximately four months after surgeries, we trained the monkeys to touch a target (PVC elbow hung on the cage) and remain stationary in the front of their cage and present for injection using positive reinforcement training techniques. We calculated time it took to reliably complete each task, i.e., perform on command for three consecutive training sessions. Animals were trained 2-3 times per week for a total of 20 sessions. While all subjects learned to reliably touch the target, it took significantly fewer sessions to train the intact compared to castrated males (Mann Whitney $U = 6.5$, $p = 0.02$). The intact animals were more likely than castrated subjects to present their hindquarters (chi square = 4.4, $df=1$, $p = 0.036$). Five of the intact males (83%) compared to one castrated male learned this task. These data suggest that testosterone may have a role in training success, at least for these relatively simple tasks.

190. THE DEVELOPMENT OF A DERMESTID BEETLE (*DERMESTES SP.*) COLONY FOR COMPARATIVE PRIMATE ANATOMY AND FORENSIC ANTHROPOLOGY

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Nonhuman primates have long been used in research due to their similarities to human physical, behavioral, and genetic traits. The purpose of this project was to develop a nonhuman primate skeletal collection for comparative research. The project focused on technique refinement and development of an appropriate microenvironment for dermestid beetles. Detailed data were collected on all aspects of project advancement. Multiple resources were needed to procure reproductively active beetles. A specialized room was constructed to regulate temperature and humidity important for larvae maturation and reproduction. A period of at least six months was required to develop a sustainable colony of approximately 10,000 healthy larvae and adults. Our research indicates that this is the minimum number required to completely render a 2-15kg nonhuman primate skeleton. Additional steps were required prior to and following rendering including: evisceration, primary defleshing, cleaning and degreasing, sanitizing and whitening, and labeling each bone with the corresponding animal identification number. The current goal is to increase the collection in both number and species variety and provide other researchers with this important resource. While the colony was challenging to initiate, it is and will be a valuable comparative tool for scientific study.

191. COMPARING SYSTEMATIC OBSERVATION METHODS FOR IDENTIFYING BEHAVIOR PROBLEMS IN LABORATORY-HOUSED MACAQUES: WHEN IS ENOUGH, ENOUGH?

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Nearly all nonhuman primate research facilities conduct regularly scheduled behavioral observations to identify and subsequently treat behavioral problems [Baker et al., 2007]. Since resources and personnel are limited, it is important to develop an efficient monitoring plan that can detect abnormal behaviors at high accuracy with minimal observation time. This will leave more time to spend on therapeutic interventions to prevent and treat behavioral problems which will lead to an overall better outcome for each animal. Here we compare two observational methods used to survey our entire caged macaque population (*Macaca fascicularis*, *M. mulatta*, *M. nemestrina*) across three Seattle facilities Dec 2013-June 2014: “Zones” focal-group one-zero sampling (10 min duration) and “Homecage” focal-animal continuous recording (5 min duration). Both methods had very similar detection rates. Out of 588 macaques 29% (Zones) and 30% (Homecage) showed some atypical behaviors (e.g., over-grooming, locomotor stereotypy, other stereotypies, self-suck/-clasp). In addition, both methods detected the most concerning abnormal behaviors (self-biting, self-hitting, floating limb) at identical rates (2% of the population). While the two methods seem to have the same payout, Homecage was a larger time investment, requiring approximately 78 h (or 8 min staff time expenditure per animal) vs 30 h (3 min per animal) for Zones monitoring. Therefore, for detection of abnormal/atypical behaviors Zones monitoring is the more efficient method. Support: NIH grants P51 OD010425, R24OD01180-15.

192. CAPUCHIN MONKEYS (*CEBUS APELLA*) DO NOT DELIVER FOOD TO PARTNERS IN A BAR-PULL TASK

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Altruistic behavior is thought to have evolved to help kin and those likely to return the favor. However, the proximate mechanisms underlying altruistic behavior have proved difficult to uncover. Here, we examined low-cost altruism in a prosocial species, capuchin monkeys. Using a bar-pull apparatus, a subject (operator) was given the opportunity to deliver food to a partner (recipient) at a small cost to itself. By manipulating the recipient’s access to food, we examined whether operators were sensitive to their partner’s needs. We predicted if the operators paid attention to recipients’ needs, the operators would pull more often when the recipients could access the food than when the recipients could not. Overall, the operators’ pulling behavior varied among the five conditions (Friedman’s test, $\chi^2(4) = 33.96$, $p < 0.001$). Operators pulled significantly more when they could access food themselves compared to when the recipient was absent and food was inaccessible (Wilcoxon signed-rank test, $Z = -2.93$, $p = 0.003$), suggesting the capuchins understood the contingencies of the task. Although operators pulled significantly more often when the recipients could access food compared to the baseline condition ($Z = -3.36$, $p = 0.001$), they were no more likely to deliver rewards to their partners when food was accessible compared to when food was inaccessible ($Z = -1.66$, $p = 0.09$). Thus, although operators

understood the task and were generally prosocial, they did not attend to specific needs of recipients.

193. SOCIAL HOUSING STRATEGIES FOR CAPTIVE *MACACA FASCICULARIS*

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The importance of social housing of captive NHPs to their psychological well-being has been well established, but even as late as 2007, more than half of indoor housed primates in the US were singly housed [Baker et al., 2007]. Our site originally group housed juveniles in indoor gang-style pens. Facility renovation and expansion increased pair and triple housing space necessitating the development of social housing strategies to fill that space. Our site has pair or triple housed greater than 1000 new sets of animals per year, with many lessons learned. The aim of this presentation is to share pairing strategies learned in the evolution of the social housing program, including methodology and temperament characteristics of successful social housing sets. A difference in success rates in pairing juveniles (100%) vs sub-adults (96-97%) vs adults (100% females, 83% males) drove the development of different processes for pairing depending on age class. The pairing process was streamlined for the first two classes, while a technique of analyzing pre-pairing behavior using a modified version of the human intruder test, and using the assessment to select particular partners, was developed for the adult males that increased the pairing success by 8%. These modifications resulted in more efficient use of labor resources and increased our level of social housing across the colony.

194. RING-TAILED LEMUR (*LEMUR CATTAL*) LATRINES ARE NOT A COMMUNICATION SIGNAL AT BERENTY RESERVE, MADAGASCAR

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Irwin et al. [2004] suggested that *Lemur catta* might use latrines, concentrating their feces in conspicuous deposition sites. We observed a wild lemur troop of seven individuals to determine whether feces and/or latrines are a communication signal. If lemurs communicate with latrines, we predicted that they will overlap their feces, choose conspicuous defecation sites, combine defecation with scent marking, and investigate/overmark feces. October 2006, we recorded all occurrences of defecation and scent marking, noting substrate used, in 5-min group scan samples for ten 10-hour days. To determine whether lemurs investigate feces, June 2010, we collected feces from a distant troop each morning, placed these samples 10cm from a water dish, and observed the response of a tourist area troop. We recorded 284 defecations and 1456 scent marks. All scent marks were deposited on objects; all feces landed on the ground. As many as seven defecations occurred within one scan, typically before 7:30am as the lemurs left the sleeping tree, but with no obvious accumulation. During 27 agonistic intergroup encounters, they deposited 72 scent marks but defecated only three times. Over the five days of the experiment, females went to the water dish seven times, other individuals walked nearby, but none investigated the feces. Lemur feces do not appear to be a communication signal. Supported by Committee for Research and Exploration, National Geographic Society.

195. IS URGENCY ENCODED IN THE *TSIK* CALLS OF COMMON MARMOSETS?M. M. Mulholland^{1,2}, M. G. Rice², K. R. Chudeau² and N. G. Caine²¹University of Nebraska-Lincoln, Department of Psychology, Lincoln, NE, 68588-0308, USA,²California State University San Marcos

Referential alarm calls have been demonstrated in two closely related species of tamarins (*Saguinus fuscicollis* and *S. mystax*) and in Geoffroy's marmosets (*Callithrix geoffroyi*). However, it is not known if marmosets modulate call production to indicate the urgency of predatory threat. We hypothesized that marmosets would respond with higher rates of *tsik* calls to a large, rearing rattlesnake model (higher risk) than to a smaller rattlesnake model in a non-rearing position (lower threat). These stimuli were presented to six captive common marmosets (*Callithrix jacchus*) while individually isolated in a small area of their enclosure. Contrary to our hypothesis, there was no significant difference in the number of *tsik* calls given to the two models over a one-minute exposure ($t(6) = 0.51$, $p > 0.05$). However, the marmosets did spend significantly less time at the front of the enclosure (where the models were presented) when exposed to the higher threat model ($t(6) = -2.67$, $p < 0.05$) suggesting that the monkeys did discriminate between the two stimuli. These findings do not support the hypothesis that marmosets alter the rate of production of *tsik* calls in an urgency-based manner. However, rate may not be the only feature of the calls that signals urgency. Further acoustic analyses need to be performed to determine if the structure of the *tsik* calls given in high and low threat conditions are different.

196. RELAXED EYE CONTACT: DESCRIPTION OF AN AFFILIATIVE BEHAVIOR OBSERVED IN CAPTIVE RHESUS MACAQUES (*MACACA MULATTA*)A. C. Nathman¹, D. L. Hannibal¹, B. A. Beisner^{1,2} and B. McCowan^{1,2}¹California National Primate Research Center, University of California-Davis, Davis, CA, 95616, USA, ²University of California-Davis, Department of Population Health & Reproduction, Davis, CA 95616, USA

Direct eye contact is generally understood to be agonistic in rhesus macaques. Less is known about the use of sustained, mutual eye contact as an affiliative behavior among rhesus macaques. Observations conducted at the California National Primate Research Center (CNPRC) reveal an affiliative behavior we call relaxed eye contact (REC). REC is characterized by direct, sustained, reciprocated eye contact between animals in proximity or contact sitting, and occurs in the absence of agonistic or submissive behaviors. Using an all occurrence sampling method we recorded 141 dyadic bouts of REC among 55 individuals across 600 hours of observation of three outdoor captive groups of rhesus macaques (N=285). Study subjects' ages ranged from 2-18 years old (mean=6.6). Among REC participants 76% are female, 24% are male, and 94% of REC interactions occur between individuals within the same matriline while 6% occur between individuals from different matrilines. Interestingly, within a social group, this form of affiliation was observed in some matrilines but not others and not all members of participating matrilines were observed in REC interactions. Study groups included mixed indoor and outdoor reared animals, but primarily animals with early exposure to species-typical outdoor social groups were observed engaging in REC, suggesting this is an important condition for exhibiting this behavior. Further study of REC affiliation is needed to uncover the function of this behavior.

197. USE OF A TABLET AS ENRICHMENT FOR ADULT RHESUS MACAQUES

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Finding primate enrichment that is not food-based is challenging, but tablet technology offers a versatile and engaging option. We tested the use of Kindle Fire tablets as enrichment for 12 male rhesus macaques (*Macaca mulatta*). We acclimated monkeys to the tablet for three days before providing them three different apps; one passive (a colorful screen saver-like app) and two interactive apps (one in which brightly colored balloons ‘popped’ when touched, and one that allowed monkeys to ‘paint’ on the touchscreen). Each app was presented to monkeys for three 30-minute sessions, which were videotaped. We utilized GLMMs to analyze the amount of time spent touching and closely inspecting the tablet. As expected, animals tended to spend more time touching and inspecting the tablet when presented with interactive compared to passive apps ($B = -1.28, p < 0.01$). They were most likely to use the balloon app ($B = 2.15, p < 0.01$), although their interest in this app diminished over time ($B = -0.49, p < 0.01$). There was a great deal of individual variation in tablet use. Animals labeled as inhibited on temperament tests ($N=3$) did not touch the tablet with any of the apps. Tablets such as the Kindle are likely good enrichment items for caged macaques, although they may be of more value to some individuals than others. Further, apps that are interactive, as opposed to passive, may provide a better enrichment option.

198. THE LONG TERM EFFECTS OF EARLY REARING ENVIRONMENT ON DAYTIME AND NIGHTTIME BEHAVIORAL ACTIVITY OF ADULT MALE RHESUS MONKEYS (*MACACA MULATTA*) ACROSS THE LIFESPAN

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In humans, early life adversity is associated with deleterious health outcomes across the lifespan. Young nursery-reared (NR) animals are reported to be more reactive than their mother-reared (MR) counterparts, but show less gross motor activity. Few studies have examined the persistence of the effect of early rearing to physical health, activity, and morbidity in adult animals. We measured activity levels of adult male rhesus macaques with different early infant experiences ($N=6$, MR; $N=6$, NR). Activity levels were measured with a Actiwatch™ actimeter yearly in the home cage environments over the span of the six years (10 to 16 years). The 24hr activity count averages were calculated for day and night-time activity. Monkeys were more active during the light portion of the light:dark cycle. Daytime activity decreased significantly with age ($F(5,50) = 3.51, p = 0.008$). No differences in behavioral activity between the two rearing groups were observed in either phase of the light cycle. These data provide evidence that monkeys with differential early rearing experiences exhibit similar activity patterns in adulthood and into the middle-age period where we would expect declining activity. Our data suggest that rearing group differences in motor activity observed in the infant and juvenile period are not maintained in adult animals and suggest previously reported activity differences may require a salient environmental challenge to be observed.

199. INTERHEMISPHERIC CONNECTIVITY IN TWO SPECIES OF PRIMATES: SPIDER MONKEYS (*ATELES GEOFFROYI*) AND STUMPTAIL MACAQUES (*MACACA ARCTOIDES*)

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The objective of this research was to analyze the ratio of corpus callosum surface area (CCSA) to brain volume (BV) of the spider monkey (*A. geoffroyi*) and stumptail macaques (*M. arctoides*). In an evolutionary scope, studies have shown that increased brain size is associated with reduced interhemispheric connections; the CCSA should be relatively smaller in primates with the largest brains, at the same time, this should correlate with hemispheric dominance and lateralization phenomenon resulting in increasingly independent hemispheres. It has also been suggested that the CCSA is a measure of the degree of connectivity between the left and right hemispheres of the brain. To test this hypothesis, we used MRI scans (3T Achieva-Phillips scanner) from 14 subjects. All measurements were made with the Osirix analysis software program. CCSA was identified using a biplanar method. Measurements were obtained by manual trace and compared by different observers (N=6) using Cronbach's alpha reliability index with a significance of 0.99. Student's t test was used to compare the mean ratio of corpus callosum ($t = 0.11$, $p < 0.05$). We confirm the tendency that Rilling and Insel [1999], report: the mean ratio of corpus callosum for Cebidae such as spider monkeys is 1.10 and for Cercopithecidae such as stumptail macaques is 0.97. These ratios and phylogeny data suggest that interhemispheric connections via corpus callosum have a reduction tendency in large primate brains.

200. EFFECTS OF LONG-DISTANCE TRANSPORT ON SOCIAL GROUPS OF RHESUS MACAQUES (*MACACA MULATTA*)

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Few published accounts exist describing the long-distance relocation of nonhuman primate social groups and the social and clinical consequences of such a move. Yerkes National Primate Research Center acquired nine intact social groups of rhesus macaques (N=97) from another primate facility during two separate time points in 2014. Groups were transferred from an indoor facility to outdoor sheltered housing at Yerkes Field Station. Group size ranged from 4-15 and individuals ranged in age from one month to 17 years old at time of shipment. The first cohort of monkeys (N=40; 21 females) were relocated in the spring and experienced a quick transition to Yerkes standard diet whereas the second cohort (N=57; 27 females) relocated in fall and experienced a gradual diet transition. Body weights were collected prior to relocation and during five quarantine examinations, approximately 2-3 weeks apart. These data show significant weight loss across both cohorts of adult females between pre-shipment and 90 days post-shipment (mean difference = 0.87kg-1.25kg) ($F = 32.17$, $p < 0.001$). Additionally, the overall weight loss among female adults between the two cohorts was significant (% change: cohort 1 = 12.92%; cohort 2 = 15.16%) ($F = 3.15$, $p < 0.017$); however, multiple linear regression indicates starting pre-shipment weight was a higher predictor of weight loss ($F = 18.48$, $p < 0.001$). These data suggest that even

with a gradual diet transition, significant weight loss in larger animals following relocation is likely to be unavoidable.

201. PROMOTING SPECIES TYPICAL POSITIONAL BEHAVIOR IN CAPTIVE OWL MONKEYS

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Study of the nocturnal owl monkey (*Aotus* spp.) has been limited in nature; in captivity owl monkeys have been used predominantly in biomedical research, as well as some recent behavioral studies. As owl monkeys occupy a unique temporal niche and differ markedly from other platyrrhines, it would be beneficial to have a better understanding of their positional behavior and locomotion for the purposes of captive management. At the DuMond Conservancy there is a captive colony of *Aotus nancymaae* housed in semi-naturalistic environments which provide both natural perching and PVC perches simulating the spring of living branches and encouraging natural locomotor behavior. Twelve individuals of ages 7-11 were selected as representatives for natural locomotor behavior in adult *Aotus* for this study. Preliminary results indicate high rates of leaping, 15 per hour (± 4.197). Leaps observed were divided into four types: horizontal, vertical, bounding, and vertical-cling leaps. High rates of clinging and suspensory locomotion were also observed, approximately 22 times (± 11.188) and 4 times (± 2.512) per hour respectively. Instantaneous sampling is being utilized in order to obtain an accurate and random data set of *Aotus* positional behavior. Cages have been modified with additional vertical substrates of natural materials. This study aims to bring to light the special considerations that should be taken in order to ensure best designed enclosures to allow species typical behaviors in captivity.

202. ASSESSING THE SENSITIVITY OF THE PARASYMPATHETIC NERVOUS SYSTEM TO THE PRESENCE OF SOCIALLY MONOGAMOUS PAIR MATES USING ELECTROCARDIOGRAPHY

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High quality relationships reliably promote psychological well-being and physical health, whereas diminished or lack of social support conveys detrimental effects. Cardiovascular regulation by the autonomic nervous system is a candidate mechanism by which relationships can exert these dually beneficial effects. The autonomic nervous system dynamically regulates heart rate with the parasympathetic nervous system (PNS) inhibiting the sympathetic nervous system to slow heart rate. We investigated the sensitivity of the parasympathetic nervous system to the presence of the pair mate in socially monogamous titi monkeys (*Callicebus cupreus*). We utilized external electrocardiography with four adult titi monkeys to noninvasively index respiratory sinus arrhythmia (RSA), a PNS measure. Recordings were taken during three consecutive 10-minute test conditions: (1) social isolation, (2) stranger of the opposite sex present, and (3) attachment partner present. An analysis of two adult males in HLM with minute block of data nested within conditions within monkey revealed that RSA was lower in the presence of the attachment partner

than during social isolation and when the stranger was present ($B_0 = -0.79$, $t(58) = 3.16$, $p < 0.01$). This indicates that the PNS is responsive to a pair mate in a socially monogamous primate species. This is the first study of RSA in titi monkeys and lays the foundation for developing titi monkeys as a translational model to study the social regulation of the autonomic nervous system in adult attachments.

203. SUSTAINABLE PALM OIL AND ORANGUTAN CONSERVATION EDUCATION WITH COLLEGE STUDENTS

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Palm oil production is an industry that threatens Southeast Asia's biodiversity, including the endangered orangutan. As a result, there is increasing interest in promoting and purchasing sustainably produced palm oil products. Sustainably produced palm oil complies with globally agreed upon environmental standards that produce less environmental impact and damage to orangutan habitats. However, there is still a lack of public knowledge about this environmental issue. The goal of this project was to assess how education about this issue can affect environmental attitudes and actions. We offered community college students ($N=43$) information about sustainable palm oil through a video (approximately five minutes long) about sustainable palm oil and the benefits that this product can provide for orangutans. They were also offered a sustainable palm oil purchasing guide to consult while shopping. The students completed pre- and post-surveys to assess awareness and perception of the use of sustainable palm oil. Results showed a significant increase in awareness of sustainable palm oil following the exercise (Wilcoxon: $p < 0.005$). A majority of the students indicated that they would continue to shop with the aid of a palm oil guide in order to purchase items that contained sustainable palm oil. This project demonstrates how simple educational interventions can promote pro-environmental behavior and help protect the habitat of primates.

205. IMMUNOGENETIC REGULATORY VARIATION ASSOCIATED WITH PARASITE INFECTION IN THE UGANDAN RED COLOBUS (*PROCOLOBUS RUFOMITRATUS*)

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Revealing immune processes that underlie genotype-phenotype associations will provide a better understanding of complex host-pathogen adaptation in nonhuman primates. While research in this area has primarily focused on protein-coding regions of the genome, the role of regulatory genetic variation in controlling an organism's immune response to infectious disease remains largely unknown. To address this, we tested associations between the core promoters of two immune-related genes and gastrointestinal helminth infection intensity in the Ugandan red colobus at Kibale National Park, Uganda. Our two candidate genes were IL-4 and MHC-DQA1, both of

which have known associations with gastrointestinal helminth infection, and we focused on the whipworm parasite (*Trichuris*), which has known fitness consequences in humans. We sequenced the core promoters of IL-4 and MHC-DQA1 in 31 Ugandan red colobus monkeys and reconstructed individual haplotypes. While the core promoter of IL-4 contained no variation, fifteen individual regulatory variants were identified in the functionally important transcription factor binding sites of the MHC-DQA1 core promoter. Genotypes for each SNP were tested for associations with whipworm infection intensity using a generalized linear model. Our results identified two functional regulatory variants associated with increased infection intensity for the heterozygote genotype (SNP-121, $p = 0.007$, and SNP-197, $p = 0.012$). This work highlights the importance of regulatory genetic variation in determining disease susceptibility and gene expression as an explanatory mechanism underlying disease association.

206. ANALYSIS OF HUMAN (*HOMO SAPIENS*) AND CHIMPANZEE (*PAN TROGLODYTES*) GENOMIC SEQUENCE SUPPORTS ROLE OF rDNA IN EXTREME CHROMOSOME LENGTH EVOLUTION

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Eukaryotic chromosomes are inexplicably long. After accounting for all known features (functional and non-functional), roughly 35% of primate genomes cannot be assigned a biological role. Ribosomal RNA genes occur as clusters of identical repeated units and undergo an unusual evolution – termed ‘concerted evolution’ – that results in keeping rRNA genes identical throughout all repeated copies. We have used the genomes of human (*Homo sapiens*) and chimpanzee (*Pan troglodytes*) to test our hypothesis that rDNA genes on the edge of clusters cannot participate in concerted evolution, and thus accumulate mutations, becoming pseudogenes. The hypothesis was tested by obtaining the nearest 200 kilobases (kb) of sequence adjacent to each cluster using GenBank, and by searching for sequences derived from rDNA genes via alignments using BLAST; then comparing this result to regions of the genome far removed from rDNA clusters. The results support our hypothesis. In each nearest rDNA edge examined, an excess of rDNA-like sequence occurs compared to distant sequences (averaging 2.26 kb of 10 kb proximally and 1 kb of 10 kb distally in cluster edges; compared to 0.5 kb of 10 kb from sites on chromosomes with no rDNA cluster) – inferring a trend to degradation. These results support our model of rDNA cluster mechanics and strongly suggest that at least a portion of the ‘unaccounted’ 35% of chromosomes is degenerating rDNA sequence distributed throughout the genome.

207. MANAGEMENT STRATEGIES FOR ABANDONED RHESUS MONKEY INFANTS (*MACACA MULATTA*) IN AN SPF BREEDING COLONY PART II: ORPHANS

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The Colony Management Unit at the Yerkes National Primate Research Center (YNPRC) Field Station has a high rate of success in fostering abandoned rhesus infants in the SPF Breeding Colony. However, it’s critical for Colony Management and Behavioral Management to also have a plan to raise abandoned or orphaned monkeys that maximizes appropriate social behaviors and

minimizes stereotypical behaviors. In 2014, 12 orphans were successfully grouped with an adult male and two females. Prior to this run grouping, multiple housing conditions were utilized. During the initial 16 weeks, animals were either housed singly or in stable pairs. During the next 10 weeks, all animals were rotationally pair-housed on a weekly basis with daily 60-min group play sessions. Behaviors from each animal were recorded both in caging and during play at least three days a week for 5-min sessions. Infants were then merged into one group and placed into a run. Adults were introduced 48hr later. A significant reduction in digit sucking ($t = 8.43$, $p < 0.0001$) was observed once all animals were rotationally pair housed and play was initiated. Mean rates of occurrence decreased from 14.26 events to 3.4 per week. There was no additional decrease in rates of digit sucking once animals transitioned to run housing. These data suggest that social stimulation is critical to reduce stereotypical digit sucking in orphaned rhesus monkeys.

208. VARIABILITY SELECTION HYPOTHESIS, WEED MACAQUES, AND BODY SIZE VARIANCE

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Variability Selection Hypothesis (VSH) proposes that early *Homo* gained adaptive benefit from being flexible in novel or unpredictable climates. Increased intra-taxon variation in body size and the expansion of geographic ranges in early *Homo* populations suggests greater phenotypic and developmental plasticity. Similar levels of ecological flexibility have been documented in some species of macaques, earning them the moniker of “weed species”. We compare body size variance between weed and non-weed macaques to determine whether intrataxon variation in body size positively correlates with ecological flexibility, as proposed by the VSH. We used two sources of body size data for all available taxa: original data on postcranial osteological body size estimators (seven species, $N=49$), and published body masses for nineteen species. Fourteen osteometric body size estimators on the humerus, radius, ulna, femur, and tibia were included. All estimators show a tight correlation with body mass: R^2 values range from 0.79 to 0.95 with a mean of 0.9. Variance per estimator per species was calculated, as proxies for body mass variance. Averaged estimator variances in non-weed species range from 1.71-11.34, but only 2.26-4.36 within weed species. This data analysis indicates that weed macaques do not exhibit more intrataxon body size variance than non-weeds. Macaques are under-utilized ecological referents for human evolution, and this genus’ diversity is informative for understanding the role of adaptive flexibility in primate evolution generally.

209. SMARTA: SUBJECT-MEDIATED AUTOMATIC REMOTE TESTING APPARATUS FOR COLOR VISION DISCRIMINATION TASKS

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Primate behavioral studies often rely on human observation for data collection. This is especially true in captive and laboratory settings. However, human error and imperfect inter-rater

reliability can contribute to erroneous data collection and entry. Furthermore, the physical presence of a researcher can influence research outcomes. The subject-mediated automatic remote testing apparatus (SMARTA) was developed in an effort to avoid human error, inter-rater disagreement, the observer effect, to control for visual stimuli, and to automatically log all observational data to the cloud. SMARTA is an innovative novel apparatus that integrates motorized food delivery (food reinforcement), remote control, and cloud-based data logging. SMARTA is a color-calibrated tablet-based testing platform, controlled remotely via smartphone app, which automatically dispenses food rewards and logs data online. With SMARTA, a researcher can remotely control an experiment without influencing subjects under test using Android apps for smartphone and tablet that interconnect using Bluetooth. Further, it automatically records data and uploads it to a Google spreadsheet for later analysis. Recent color vision studies have used naturalistic settings to assess and determine whether primates are either dichromats or trichromats. SMARTA can be used for touch screen discrimination tasks, especially color vision studies where hues and brightness are carefully controlled. Since it utilizes a consumer Android tablet and smartphone rather than specialized hardware, SMARTA can be built inexpensively.

210. FACTORS THAT INFLUENCE THE SUCCESS OF MALE INTRODUCTIONS TO ESTABLISHED BREEDING GROUPS OF RHESUS MACAQUES (*MACACA MULATTA*)

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YNPRC Field Station Colony Management is tasked with introducing new breeder males to SPF rhesus breeding groups. Males are introduced every three years to increase genetic variability, avoid inbreeding and decrease the sex ratio. The success of these introductions is dependent on several factors: (1) established relationships between males, (2) sexual attractiveness and receptivity of both sexes, (3) male experience, (4) group stability, and (5) presence of all high-ranking individuals. Of 13 introductions, three were unsuccessful. The key behaviors that were observed during failed introductions included male/male fighting, severe male and female trauma, increased female aggression, and lack of a relationship between the male(s) and alpha female. We compared trauma rates in one social group that experienced an unsuccessful (newly paired males) and successful introduction (established trio of males). While there was no difference in trauma rates across all of the animals, there was a significant difference in trauma rates in the higher ranking families. In the unsuccessful introduction, trauma rates among the top ranked female families was significantly higher than during the successful male introduction ($t = 2.79$, $p < 0.04$). Further there was no male-male trauma observed during the successful male introduction. These data suggest that the stability of male relationships can predict the success of male introductions and influence the stability of the dominance hierarchy in socially housed rhesus macaques.

211. SERPENTINE SHAPES WITH COMPLEX TEXTURE ENHANCE VISUAL INSPECTION BY COMMON MARMOSETS (*CALLITHRIX JACCHUS*)

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Primates have a suite of sensory and behavioral characteristics that allow them to quickly detect and react to snakes. Laboratory studies have shown that the sinusoidal shape of snakes is critical to their rapid detection, but few studies have addressed other perceptual characteristics of snakes that generate investigatory and defensive reactions. In a replication and extension of an earlier study, in which we found that patterns etched on sinusoidal shapes seem to be important in generating anti-predator reactions by marmosets, we tested the hypothesis that a scaled texture would be most salient in evoking visual inspection. Using a blind in which we could control exposure to the stimuli, we showed ten captive marmosets textured and un-textured snake-like (sinusoidal shaped) and control (triangle) stimuli. Data were analyzed with bootstrapped paired t-tests, $\alpha = 0.05$. In agreement with the previous data, we found that the marmosets spent a significantly greater proportion of time visually inspecting snake-like stimuli ($M = .20$, $SE = .05$) than control stimuli ($M = 0.15$, $SE = 0.04$), and that textured snake-like stimuli generated significantly more looking time ($M = 0.21$, $SE = 0.05$) than the un-textured snake-like stimulus ($M = 0.17$, $SE = 0.04$). The starred and scaled snake-like stimuli evoked similar looking times and were more salient than the lined snake-like stimulus, but this comparison did not reach statistical significance. This suggests that marmosets are prone to paying attention to serpentine shapes that have complex texture.

212. URINARY INDICES OF HEALTH IN FEMALE BLACK HOWLING MONKEYS (*ALOUATTA PIGRA*) IN BALANCÁN, MEXICO: COMPARING GROUPS WITH HIGH AND LOW IMMATURE-TO-FEMALE RATIOS

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Higher ratios of immature individuals to adult females in groups of nonhuman primates indicate greater reproductive output per female and potentially greater reproductive success for those females compared to females in groups with lower ratios. To assess possible differences in general health of females in low and high ratio groups, urine samples from female black howling monkeys at Ranchería Josefa Ortiz de Dominguez, Balancán, Mexico were collected during a 2-month period. The high and low ratio groups contained females from groups in both habitat types (playón and rainforest fragments). Urine samples were tested in the field for 10 parameters with commercially-available reagent strips. Females in the groups with lower ratios (< 1.0 ; 4 groups; mean = 3 females/groups; 21 samples) had higher proportions of samples with ketones, proteins, nitrites, and leucocytes than did females in the groups with higher ratios (> 1.0 ; 11 groups; mean = 2.3 females/group; 99 samples), suggestive of poorer health, although differences were relatively small. Females in groups with lower ratios had urine samples that were more alkaline, on average, and of higher specific gravity, although mean values in both groups were within the normal range for both parameters. While longitudinal study of individuals is necessary to document fully differences in reproductive success, the patterns of results reported here suggest differences in general health of females might contribute to differential reproduction.

213. QUANTITATIVE ANALYSIS OF ALOPECIA IN A LARGE POPULATION OF INDOOR-HOUSED RHESUS MACAQUES (*MACACA MULATTA*)

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Nonhuman primate alopecia may be a potential marker of compromised welfare. However evidence suggests developmental, reproductive, and seasonal factors may influence expression. Our goal was to examine how these factors may help explain alopecia within our colony. Using ImageJ, we measured alopecia as percent of total surface area in a mixed age and sex group of rhesus macaques (N = 197). Images were collected during routine clinical evaluations at three time points over one year (winter13: summer13: winter14). Analysis showed a significant main effect across time ($F_{(2,195)} = 3.80$, $p < 0.05$), with winter13 lower than summer13 ($p < 0.01$) and winter14 ($p < 0.05$). A marginal effect of sex was observed ($p = 0.07$). Six age groups were calculated to assess developmental effects: 0-3yrs (N=63), 3-6yrs (N=41), 6-9yrs (N=42), 9-12yrs (N=22), 12-15yrs (N= 13), 15yrs< (N=16). Analysis revealed a significant main effect for age ($F_{(5,185)} = 5.87$, $p < 0.0001$), with animals 0-3yrs having less alopecia than all groups except 15yr< group ($p < 0.05$). 3-6yr animals had significantly greater alopecia than 6-9yrs and 15yrs<, and significantly less area than 12-15yrs ($p < 0.05$). We found that both pubertal transition and middle age animals are at the highest risk for alopecia expression. This suggests these periods are primary targets for future study.

214. HOW DO PRIMATOLOGISTS ENGAGE WITH LOCAL HUMAN POPULATIONS? COMMUNITY ENGAGEMENT IN MADAGASCAR

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Primatologists often engage with local human populations when conducting field research, in a range of contexts and roles. While engagement is often need-based, to help facilitate research, the ultimate aim is to translate and disseminate research goals and findings. I focus on primatologists conducting research in Madagascar, and discuss the types of interactions that occur with local communities. Researchers interact with community members as teachers, students, collaborators, and scientific experts. I highlight proximate and ultimate goals of these interactions from the researchers' perspective. Proximate goals may focus on benefits to research. For example, training technicians in new field methods helps facilitate data collection. Local knowledge of the site and location of animals, previous (published and unpublished) research, and suitability of certain methods can be invaluable to researchers. Ultimate goals include capacity building at universities and specific field sites, disseminating results to policy makers and communities, and developing long-term research collaborations. It is hoped that community engagement promotes scientific literacy in graduate students involved in research, and non-formally educated local populations; a non-commoditized valuation of the natural environment and scientific research; and innovative research projects. I discuss plans for more active, measurable community engagement as a result of incorporating capacity building during grant proposal preparation; costs and benefits of the various types of interactions that researchers experience; and how we can assess whether goals are met.

215. INFLUENCES OF INTRAGROUP SCRAMBLE COMPETITION AND INTERGROUP CONTEST COMPETITION WITHIN THE MODULAR SOCIETY OF RED-SHANKED DOUCS (*PYGATHRIX NEMAEUS*) IN SON TRA NATURE RESERVE, VIETNAM

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From 2010 through mid-2011, 259 hours of behavioral data were gathered on the red-shanked doucs (*Pygathrix nemaeus*) in Son Tra Nature Reserve, Da Nang, Vietnam. The red-shanked doucs are an endangered primate, and Son Tra contains the second largest remaining population of doucs in Vietnam. Data was gathered on social structures and organization, group and unit cohesion, activity patterns, ranging behaviors, and feeding ecology. The social organization of the doucs consisted of groups (average of 18 individuals) composed of an average of three units or subgroups (average of 7 individuals). Unit and group member was stable and did not change. Daily, the doucs followed an activity budget pattern typical for the genus *Pygathrix*, and exhibited a daily fission-fusion pattern between units which was significantly correlated to their daily activity budgets. When units were fused they rested significantly more and when units were fissioned they moved, fed, and vocalized significantly more, and were significantly more vigilant. We argue that this is an adaptation to avoiding intragroup scramble competition, and the effects of both intragroup scramble and intergroup contest competition in maintaining contact and coordination between dispersed foraging units within a modular society.

219. TUGGING AT TOOL USE

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The origins and character of tool use in primates remain veiled in mystery. Nonhuman primates use their hands dexterously, manipulate objects adeptly and are easily trained to use simple hand tools. Yet they rarely use tools in natural settings, and when they do, their activity is structurally simple. Tool use appears in some populations of some species but not in others that seem equally well-equipped for such activity. Tufted capuchin monkeys (*Sapajus* spp.) and chimpanzees (*Pan troglodytes*) are among the rare taxa in which some populations use tools routinely in natural settings. They therefore afford an opportunity to consider how and when a primate discovers how to solve a problem using a tool, how it masters using a tool with skill, and how once solving a problem using a tool is discovered by one individual, others living in the same group come to share the skill. I will use examples drawn from studies with tufted capuchin monkeys, chimpanzees and children to illustrate skills deployed in using tools, characteristics that likely limit tool use in nonhuman primates, and the social and physical contexts that support development of skillful tool use. This body of work illustrates the multidisciplinary, interdisciplinary and collaborative character of primatology. We are beginning to tug on the veil obscuring this part of our primate heritage.

221. CONSIDERING ZOOS AS A UNIQUE OPPORTUNITY FOR EXPERIMENTAL RESEARCH AND PUBLIC ENGAGEMENT

L. M. Hopper and S. R. Ross

Lester E. Fisher Center for the Study and Conservation of Apes, Lincoln Park Zoo, Chicago, IL, 60614, USA

The topics investigated by those studying primates in research laboratories are rich and varied and have helped inform and shape our understanding of primate behavior, cognition, and physiology. Although many zoological parks encourage and facilitate observational and applied research, it was historically less common for researchers to conduct experimental research in a zoo setting, but this norm has changed in recent years to facilitate diverse experimental research opportunities in zoos. In this symposium we will highlight the range of experimental research currently being conducted with primates in zoos, including studies of behavior, cognition, and welfare. We will also consider how researchers can collaborate with zoo personnel to conduct meaningful research that also fosters connections between zoos and academic institutions. Such research is not only of theoretical interest, but, by conducting research at a zoo in a public setting, researchers are afforded a unique opportunity for public engagement with science. Primatologists can share both the findings of their research and also the methods that they use to learn more about their study species. Speakers in this symposium will cover pure and applied research from multiple zoos and with a range of species (both monkeys and apes).

222. HOW PURE AND APPLIED RESEARCH CAN GO HAND-IN-HAND IN A ZOO SETTING

L. M. Hopper and S. R. Ross

Lester E. Fisher Center for the Study and Conservation of Apes, Lincoln Park Zoo, Chicago, IL, 60614, USA

Most research with captive primates is designed to answer either a pure or an applied question, but can research address both simultaneously? Only a few studies have evaluated the physical, behavioral or cognitive impacts of behavioral testing on primates – with some revealing welfare benefits of such research – but we propose that much research could incorporate welfare assessments. For example, in a study conducted at Lincoln Park Zoo, a group of chimpanzees was required to take tokens to locations at the perimeter their exhibit and exchange them with researchers for differentially-valued food. Furthermore, they had to travel farther to obtain more-preferred rewards. This not only tested the apes' problem solving (there was no correlation between rank and task acquisition, $p > 0.05$) and decision making (chimpanzees exchanged more tokens for the better rewards, despite having to walk farther, $p = 0.046$), but it also encouraged increased locomotion by the chimpanzees. All six chimpanzees traveled more during test sessions, compared to matched control periods ($p = 0.028$). Thus, this study provided physical enrichment for the subjects – important given concerns about activity levels and related physical health issues for captive apes – and answered questions about their social cognition. We will discuss how future research endeavors can be tailored to provide benefits for primate subjects and describe methods to assess the impact of such behavioral testing.

223. CELEBRATING 25 YEARS OF FIELD TRAINING ON TINJIL ISLAND, INDONESIA

J. A. McNulty

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This year marks the 25th anniversary of field training on Tinjil Island, and the 20th anniversary of a unique study abroad program established in 1995 between the University of Washington and

the Primate Research Center at Bogor Agricultural University: the *International Field Study Program-Indonesia (IFSP-Indonesia)*. Conducted on the remote Tinjil Island, this training program brings together students from both the U.S. and institutions throughout Indonesia for a month-long field course focusing on Primatology, Conservation Biology and Global Health. To date, 312 students have participated in the field training including 222 from Indonesia and 90 from the U.S. as well as several other countries. This symposium will cover the history of the Tinjil field training, and *IFSP-Indonesia* alumni will reflect on their experiences in the program and how their participation has influenced their career trajectories.

224. FIELD TRAINING ON TINJIL ISLAND, INDONESIA: A MODEL OF INTERNATIONAL COLLABORATION FOR 25 YEARS

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Tinjil Island has served as a Natural Habitat Breeding Facility for long-tailed macaques (*Macaca fascicularis*) for over 25 years. In 1991, we established an annual field course in primatology on the island for students from IPB. The success of this field course led to the establishment of a UW study abroad program (International Field Study Program-Indonesia) in 1995 and the opportunity for students from the U.S. and Indonesia to study together in the field. Over the years, the Tinjil field training has expanded in breadth and focus which is reflected in the current title: "Field Course in Conservation Biology & Global Health: At the Human-Environment Interface." During the course, students live on the island and participate in lectures, field exercises, and conduct independent research projects. The course concludes with an outreach program for local school children back on Java. To date, a total of 312 students have participated in the Tinjil field course, including 222 from Indonesia, 77 from the U.S., and 13 from several other countries. Many have gone on to careers in science and applied fields in conservation and global health. PSSP-IPB and UW are proud to celebrate the 25th anniversary of the field training program on Tinjil and believe this program represents an excellent model of international collaboration. Supported by: PSSP-IPB; IPB International Office; OneEarthInstitute; USIPP; ORIP-NIH Grant No. P51OD010425 to WaNPRC.

226. VARIATION IN PREDATORY BEHAVIOR OF GREATER SLOW LORISES (*NYCTICEBUS COUCANG*) ASSOCIATED WITH ARTHROPOD PREY CHARACTERISTICS

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Although slow lorises (*Nycticebus* spp.) are known to consume arthropods and small vertebrates, observations of their predatory behavior are constrained by their arboreal, nocturnal lifestyle. We examined predatory behavior in 22 greater slow lorises (*N. coucang*) that were wild-

caught and housed in a rescue center in Java, Indonesia following confiscation from illegal wildlife trade. We experimentally offered lorises arthropods collected in Java (N=75 trials) and recorded their predatory behaviors using live and video observations. We hypothesized that slow lorises would adjust their behavior with the size, escape potential, and toxicity of prey. We compared rates of pre-capture behavior, attack latencies, and consumptive behaviors using a multivariate ANOVA. Lorises were faster to capture prey with higher escape potentials (MANOVA: Hotelling's Trace = 0.749, $F_{(12,43)} = 2.683$, $p = 0.009$), but their pre-capture stalking behaviors varied only with prey type (MANOVA: Hotelling's Trace = 1.331, $F_{(72,594)} = 1.372$, $p = 0.028$). Lorises selectively performed a unique investigative behavior—tongue-flicking—in response to noxious prey, suggesting chemosensory input plays an important role in assessing prey characteristics. Rates of head-cocking and visually targeting prey, and the manual grasping motion used to subdue prey, indicate that the dominant sensory modality used by hunting slow lorises was vision. Our results concur with the notion that Asian slow and slender lorises are highly specialized visual predators.

227. EATING WELL ON THE ROAD: SPATIAL STRUCTURE AND FORAGING IN FREE-RANGING CHACMA BABOONS (*PAPIO HAMADRYAS URSINUS*)

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In 1974, Stuart Altmann proposed, as specific variant of a general optimality expectation, that baboons foraging on low-density resources should forage in rank formation (i.e., move as a 'broad front'). We used spatially explicit data to test this idea. The GPS coordinates of all 13 adult members of a baboon troop at De Hoop Nature Reserve were collected across 74 all-day follows, using handheld data loggers. After correcting for temporal offset and estimating error, we extracted all inter-individual distances at 30-minute intervals (N=5204), applying the 'socioecological' model of group spacing to determine the closest distance at which moving adults will tolerate one another. This 'point of repulsion' (~3.9m) was then used to describe the distance separating optimally foraging animals. We used a subset of the data, for which we had detailed foraging information, to test the prediction that, as the proportion of optimally foraging animals increased, the bearing representing the group at its widest point would be increasingly perpendicular to the direction of travel, i.e., the animals would move in rank formation. As our data support this prediction ($r=0.33$, $p=0.05$, two-tailed test), we extend the analysis to the larger data set to provide a general description of movement dynamics, which we discuss in relation to individual decision-making.

228. ORANGUTAN COGNITION AT ZOO ATLANTA

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Face discrimination was likely advantageous in the evolution of group living species, however, little is known about how sociality relates to these skills. Sociality may play an important role in discriminating familiar vs. unfamiliar faces, as species that spend less time in social groups may have differential exposure to unfamiliar faces as compared to more social species. For example,

group living humans and chimpanzees are better able to discriminate familiar as opposed to unfamiliar faces, but we do not know whether this is related to their sociality. We tested a less gregarious species, orangutans (*Pongo* spp.), to determine whether their face discrimination skills differed as function of familiarity. In particular, it is important to test *socially housed* orangutans to rule out the influence of social housing, rather than typical socio-ecology. This is possible with zoo-housed orangutans. Using a matching-to-sample paradigm, we found that two of the three orangutans performed significantly above chance when discriminating novel photographs of familiar (Binomial tests: Madu: $Z = 2.08$, $p=0.036$; Satu: $Z = 2.08$, $p = 0.036$), but not unfamiliar, individuals indicating that within the primates, more and less gregarious species exhibit a familiarity effect. Aside from these results, I will discuss the benefits of testing a zoo-housed orangutan population for this research, which includes the aforementioned social housing situation and the ability to engage the public in this research.

229. THE TINJIL INFLUENCE: A COMMUNITY COLLEGE STUDENT'S PERSPECTIVE

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One day Matt Novak handed me a flyer for the International Field Study Program. To that point, an opportunity to do field research as a community college undergraduate was a fantasy beyond possibility. I was instantly captivated. I became a participant of the 19th annual International Field Study Program (IFSP), and had a once-in-a-lifetime opportunity, received “hands-on” experience in the field, and developed an observational research project using long-tailed macaques (*Macaca fascicularis*). During my time with the program I worked with Matt, learning to study behavior, observational methodology and statistics which augmented and extended my traditional coursework. I established connections with students from University of Washington and Indonesia, I built professional relationships with professors from University of Washington and Institut Pertanian Bogor, and I began to learn a foreign language and a new culture which was valuable for the community outreach portion of the program. My Tinjil experience gave me a new perspective on my future. I am fortunate to have been given this opportunity early in my educational career. I know the more challenging the experience, the more I will grow as student and researcher. Research opportunities like IFSP are not common for individuals who attend community college but perhaps should be. The hands-on learning and practice conducting good research early in students’ educational careers is vital to generating good scientists.

230. GIANT AYE-AYE (*DAUBENTONIA ROBUSTA*) PALEOECOLOGY AND BIOGEOGRAPHIC RANGE – A PROXY FOR MODERN AYE-AYE CONSERVATION

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The aye-aye (*Daubentonia madagascariensis*) is a highly derived Lemuriform that has developed rodent-like incisors, modified ear structures, and specialized phalanges/metacarpals. It is the world’s largest extant nocturnal primate. The only known extinct member of the family

Daubentoniidae is *D. robusta* (the “giant aye-aye”). Fossil incisors and postcranial specimens of *D. robusta* have been discovered from southwest Madagascar in Lamboharana, Anavoaha, Tsirave, and the sinkhole in Ankilitelo. A partial tibia was reported from Ampasambazimba (in central Madagascar). It would appear that *D. robusta* had a much larger paleogeographic range than modern *D. madagascariensis*: including all of the southwest and the Central Highlands. Morphologically, the giant aye-aye was merely a larger, 10kg version of the modern form. Dental microwear and skeletal comparisons between the two species show similar food, and likely, ecological niche space usage between the two species. *D. robusta* became extinct within the last 1,000 years. Skeletal morphology also suggests similarities with extinct Indriidae that also suffered anthropogenically caused extinction within the last millennia. Modern aye-ayes geographic range has been shrinking due to anthropogenic causes. Detailed geological mapping of the known fossil localities will provide a temporal component to compare range areas over time. The giant aye-aye is a useful proxy for conservation efforts of its modern descendent. It is vitally important to understand paleo-range-dispersal to aid in conservation of this highly endangered species.

231. SHARED TOUCH-PANEL TASKS AT ZOOS: A PROMISING NEW PLATFORM FOR RESEARCH, EDUCATION, AND ENRICHMENT

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Despite the successes of the few zoos that offer voluntary computer touch-panel activities to their primates, the practice has never gained enough traction to become widely adopted. This is likely due to the prohibitive costs of equipment and the need for specialized staff, but it may also be reflective of the limited objectives that zoos have traditionally placed on the usage of their touch-panels. Zoos that have implemented ape computer touch-panel programs have typically done so mainly for the purpose of scholarly research, and have given relatively less consideration to the potential for public education, behavioral enrichment, and conservation awareness. At the Indianapolis Zoo Simon Skjodt International Orangutan Center, a new computer system enables humans and orangutans to directly interact with each other over two interconnected computer touch-panel screens adjacently located on either side of a pane of exhibit glass. A variety of shared touch-panel tasks have been developed for the system, some of which are designed solely with cognition research goals in mind, while others focus more on goals of visitor engagement, immersive education, and behavioral enrichment. It is thought that the new shared touch-panel system, by fulfilling a diverse range of objectives for research, enrichment, and science education, may serve as a widely replicable exhibit platform for zoos with primates in their collections.

232. MAKING FRIENDS, MAKING COLLABORATIONS

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The experience in Tinjil was a big opportunity for learning, but it was a big challenge too. I found out about the field course in 2009 in Mexico, and in 2013 I had the chance to travel there. The three weeks I spent in the island were full of knowledge and experiences. I learned about conservation biology, global health, community outreach, animal behavior, and I could share with other students my own experience in Mexico. I realized students from Indonesia have similar

problems to Mexican students; they are avid of learning from people and researchers. They work hard and do the best always. I enjoyed all my time in Tinjil and the best things brought to my academic (and non-academic) life are: (1) I learned to get support for my academic development, (2) I experienced a new culture, religion and a whole style of life, (3) made lifelong friends, (4) I changed the way I thought about research, now I have many collaborators, (5) I developed my language skills as neither English nor Indonesian are my maternal language, (6) I found new interests and realized that the same methods can be used for studying different species, (7) there are more species of primates which need to be studied and we have the knowledge and can encourage young people to do it.

233. PLESIADAPIFORM BIOGEOGRAPHIC DISPERSAL – A STUDY OF FOSSIL GEOGRAPHIC RANGE COMPARED WITH ESTIMATED BODY MASS FOR THESE STEM PRIMATES

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Plesiadapiformes (possible stem primates) proliferated around the world during the Paleocene-Eocene. Geographic range has a strong effect on extant primate species. Dispersal can be estimated for plesiadapiformes by using fossil localities. Estimates suggest a positive correlation between geographic range and generic diversity at the clade-level for larger plesiadapiforms (ex. plesiadapids $r = 0.764$, $N=12$, $p = 0.004$). However, there is no correlation in smaller plesiadapiforms (i.e. paromomyids, picodontids, palaeochtonids, and microsypids). Plesiadapiformes were a highly diverse order with >9 families and >150 genera. These basal primates varied in size from small, mouse-like species (7 gram *Micromomys vossae*) to that of cat-sized species (3,055 gram *Plesiadapis cookei*). To better understand plesiadapiform paleogeographic-dispersal, it is necessary to have an extant, analogous species to compare them to. This study will look at a number of living species: metatherian phalangeriformes (*Trichosurus vulpecula*, *Didelphis orientalis*, and *Petaurus breviceps*), rodents (*Sciurus* species), dermoptera (*Galeopterus variegatus*), and prosimians (*Microcebus* species). New correlations (comparing ml area body mass and microwear dietary types) provide insights into dispersal regression models that failed to correlate between range and fossil genus biodiversity. This data suggests that small plesiadapiforms' geographic dispersal was highly controlled by size and diet. Plesiadapiform groups that showed no correlation (ex. paromomyids $r = 0.292$, $N= 27$, $p = 0.139$) now show a positive correlation between body mass, diet type, and paleogeographic-dispersal ($r = 0.690$, $N=9$, $p = 0.05$).

234. HOW THE INDONESIAN FIELD STUDY PROGRAM (IFSP) CHANGED MY LIFE

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During my freshman year at the University of Washington in 1999, as a lark, I applied to study long-tailed macaques (*Macaca fascicularis*) at the International Field Study Program (IFSP) held on the remote Tinjil Island of the southwest coast of Java, Indonesia. One component of IFSP was an intensive three-week field course that introduced participants to primate diversity, behavior,

ecology, and conservation. The second component required participants to conduct our own unique research projects. Unfortunately, my project was a flop. In the spring of my junior year in 2002, I returned to Tinjil Island for a summer-long trip where I would conduct my senior honors project guided by my undergraduate mentor, Dr. Randy Kyes. I arrived back at Tinjil Island confident that I had learned from the mistakes of my previous fieldwork. Although the experience had its ups and downs, I successfully completed my investigation of the habitat structure and feeding ecology of the macaque population. The experience on Tinjil Island was life-changing. I went from hopes of a business degree to pursuing a career in laboratory animal science. Furthermore, my experiences in Indonesia introduced to me—and instilled in me—a love of learning other cultures and traveling around the world.

235. INTERACTIONS BETWEEN PLANTS AND PRIMATES EXPLAIN THE DIVERSITY OF COMMUNITIES

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The assembly of biological communities is shaped by the abiotic environment and biotic interactions. Biodiversity can be measured at the taxonomic, phylogenetic and functional levels to elucidate the evolutionary and ecological mechanisms of community assembly. We measured the diversity of primates and trees along environmental gradients in southeast Madagascar. We surveyed 31 transects in five localities that varied in elevation and human disturbance. We estimated lemur abundance using distance sampling and measured trees to determine resource diversity and availability. We quantified lemur diversity based on taxonomy, phylogeny and traits related to diet, life history, sociality and morphology. Trait diversity largely tracked phylogenetic diversity (Pearson's: $r = 0.12$, $p = 0.07$). The abundance of food trees and elevation were strong predictors of lemur community structure. Lemur communities consisted of species that were more closely related than expected by chance where food trees were abundant (multiple regression: $t = -3.47$, $p < 0.01$). In contrast, where food was scarce (e.g., high disturbance, high elevation) lemur communities consisted of distant relatives. Lemur phylogenetic beta diversity was best explained by tree beta diversity ($r = 0.24$, $p < 0.01$) and tree diversity was explained by elevation ($r = 0.36$, $p < 0.001$). These results highlight the evolutionary and ecological interactions between primates and their plant resources that shape community assembly. We were supported by PCI, NSF, Rufford, MBZ, CI, SBU, LCPP, Explorer's Club, and the SPZ.

236. REFLECTIONS ON THE TINJIL ISLAND FIELD STUDY PROGRAM – 14 YEARS LATER

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I was a participant in the Tinjil Program in both 2000 and 2001; the experience would not only serve to profoundly influence the course of my career, but forever changed how I see myself and

my capabilities. While my work on Tinjil primarily involved assisting with the yearly *Macaca fascicularis* population assessment on the island, I learned far more beyond the intricacies of estimating primate densities. I came away with a love of conservation and understanding of the balance between meeting the needs of humans and protecting endangered species, an appreciation of experiencing and showing respect for other cultures, and an overall appreciation for the transformative power of education. The greatest lesson I came away with was not to believe in the limits we put on ourselves; I never thought I would survive, much less thrive, in an environment far from home – without indoor plumbing and air conditioning. My career path was impacted greatly by my Tinjil experience. I would never have considered graduate school prior to this, but was so inspired by the program that I applied to and became a graduate student in the Psychology department at the University of Washington. Now, as an instructor at Seattle Central College, I work with students from all over the world, passing on my love of primates, research methods, and the importance of cultural exchange.

237. THE INFLUENCE OF BROWSE AVAILABILITY ON BEHAVIOR AND COGNITIVE BIAS IN CAPTIVE WESTERN LOWLAND GORILLAS (*GORILLA GORILLA GORILLA*)

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We investigated the welfare impacts of browse availability in three male western lowland gorillas (*Gorilla gorilla gorilla*) at the Detroit Zoo. We systematically manipulated browse availability (*Moraceae*) over four consecutive two-week phases. We collected observational data on behavior (n = 60 hrs per gorilla) and assessed levels of “optimism” through a cognitive bias task using a simultaneous cue paradigm on a touch-screen computer. One-sample t-tests indicated that during the no browse phase, the gorillas selected the ambiguous stimulus (indicating positive interpretation) at a level greater than chance (M = 0.67, SD= 0.069; t₂ = 4.25, p = 0.051); tests for all other phases were non-significant. Using a repeated measures ANOVA with study phase as the within-subjects factor, we found that the gorillas’ behavior varied significantly (Wilks’ lambda = 0.510, F_{63, 702.313} = 2.818, p < 0.001), and univariate tests showed significant changes in time spent processing (F_{1.725, 146.600} = 4.773, p = 0.013) and ingesting (F_{2.817, 239.419} = 11.548, p < 0.001) food, locomotion (F_{2.645, 224.809} = 6.321, p = 0.001), and rates of regurgitation and reingestion (F_{1.585, 134.697} = 3.320, p = 0.050). Regurgitation and reingestion was only absent during the daily browse condition. Our behavioral data suggest that increasing browse availability had positive impacts. The finding of the cognitive bias test may reflect greater motivation to seek reward when less browse was available.

238. SCIENTIST, SCHOLAR, KNAVE AND FOOL: THE TINJIL INFLUENCE – 20 YEARS AND MOVING SIDEWAYS.

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Twenty-one years ago, at Jim Sackett's Thursday night journal club, I first inquired about traveling to the white sandy beaches of Tinjil Island in Indonesia. Just starting graduate school my interest was to learn “hands-on” about field research. Fortunately, the fledgling International Field Study Program was starting an American component. I would serve as a pilot participant. The

Field Study Program can have multiple effects. First, the program teaches the importance of social relationships. Second, good science and good questions are worth persisting on at all costs. Popularity, funding, group think and desire-based motivations have no place. Finally, for science to be successful, communication is key. Science needs to be communicated in ways our intended audiences understand. All too often, a gap is left between production and dissemination of research. Scientists and teachers frequently fail to bridge that gap. More work is needed in this area of science than any other. This idea has assumed a central role in my current pursuits as a community college professor. The Tinjil Island Field Course reveals the importance of communicating while simultaneously attempting to fill the gaps that it reveals. Tinjil and the other programs of One Earth Institute have been communicating, not to but with the world for more than 20 years spreading science to intended audiences, a model I have attempted to emulate throughout my career.

239. EXPLORING THE SOUND ENVIRONMENT OF ZOOS: BEHAVIORAL AND HORMONAL RESPONSES OF CALLITRICHINE MONKEYS TO ENVIRONMENTAL MODIFICATIONS

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Waterfall features intended to mimic naturalistic settings in zoos are popular but the effect of their sound on animals housed nearby is unclear. We assessed the influence of loud, broadband noise from a waterfall feature on three species of Callitrichine monkeys: pied tamarin (*Saguinus bicolor*, N=4), white-fronted marmoset (*Callithrix geoffroyi*, N=4), and Goeldi's monkey (*Callimico goeldii*, N=2). The first study consisted of six two-week treatment periods that featured experimental modifications of the waterfall (off/on) and access to quiet off-exhibit areas (access/no access). Behavior and exhibit use were recorded during 15-min focal observations (N=535) using instantaneous point-sampling and all-occurrences methodologies. Data were analyzed using generalized linear mixed effects models. Monkeys increased monitoring of visitor areas when more visitors were present ($t(18) = -2.55$, $p = 0.05$) and when the waterfall was on, but only when they did not have off-exhibit access ($t(8) = -3.90$, $p = 0.005$). When the monkeys had off-exhibit access, *Saguinus* ($t(6) = 2.29$, $p = 0.06$) and *Callithrix* ($t(6) = 2.54$, $p = 0.04$) spent less time inactive and *Callimico* spent more time off exhibit ($t(6) = -3.41$, $p = 0.01$) when the waterfall was on. In a follow-up study, the waterfall feature had no significant effect on fecal glucocorticoid levels of two pied tamarins, although exhibit use was modified by the waterfall. These results suggest that Callitrichines prefer quiet areas and highlight the importance of providing off-exhibit choices.

240. FIELD RESEARCH AS CAREER CONFIRMATION: INVESTIGATIONS OF THE BEHAVIORAL BIOLOGY OF LACTATION INFLUENCED BY THE TINJIL ISLAND NATURAL HABITAT BREEDING FACILITY

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The maternal environment, physiological during fetal life and behavioral during infancy, has

well-established influences on infant development. However among mammals physiological investment in the form of mother's milk continues post-natally but remains poorly understood. Although mother's milk fundamentally frames the infant's nutritional ecology and socioendocrinology, until recently very little research effort has been allocated to understanding the behavioral biology of mother's milk and infant outcomes from an evolutionary perspective. Here I will present emerging research from my Comparative Lactation Lab that addresses the magnitude, sources, and consequences of inter-individual variation of milk bioactives in humans, monkeys, and other mammals. Just as individuals vary in their "mothering style," the fats, proteins, sugars, minerals, hormones, bacteria, and other constituents in mother's milk vary substantially. That inter-individual variation is associated with differences in infant behavior and growth. For example, milk not only builds the infant's body, but fuels the infant's behavioral activity. Moreover, the biological "recipe" of milk can differ by infant sex and the critical windows for maternal effects differ between sons and daughters, likely reflecting sex-differentiated developmental priorities and sensitivities. A better understanding of variation in milk composition enhances an evolutionary biological perspective of parent-offspring dynamics. Participation in the cultural exchange and field research on Tinjil Island in 2001 was instrumental in my motivation and enthusiasm for a career as a primatologist.

242. PRIMATES AND SNAKES, AN 80 MILLION YEAR DIALOG

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The Snake Detection Theory [Isbell 2006, 2009] argues that snakes were so important as selective pressures on primates that they exerted two pulses of major evolutionary change. The first pulse favored the origin of primates, with their ancestral visual innovations; the second pulse involved the origin of anthropoids and variation in visual systems among primates on different landmasses. In this interdisciplinary symposium we use a broad approach involving molecular systematics, paleobiogeography, herpetology, ecology, behavior, and visual neuroscience to bring to attention the impact of snakes on primates now and over evolutionary time.

243. THE SNAKE DETECTION THEORY EXPLAINED

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Primates are distinguished from other mammals in large part by their highly developed visual sense. Several hypotheses have been developed to explain this evolutionary innovation, including the recent Snake Detection Theory (SDT) [Isbell 2006, 2009]. The SDT proposes that the expansion of the primate visual system occurred as a result of selection favoring avoidance of predation by snakes via early visual detection. Thus, according to the SDT, the primate lineage was established through interactions with constricting snakes, while the later appearance of venomous snakes intensified selection on the visual systems of anthropoid primates to different degrees depending on the extent of their evolutionary co-existence on the landmasses of Africa/Asia and Central/South America. Here I describe the SDT in detail, highlighting indirect evidence employed in its initial development. The SDT provides a contextual and adaptationist

platform for the talks that follow in this symposium, all of which emphasize the close relationship between primates and snakes.

245. TESTING A SHORTENED PERSONALITY QUESTIONNAIRE WITH CAPTIVE RHESUS MACAQUES (*MACACA MULATTA*) AT THE OREGON NATIONAL PRIMATE RESEARCH CENTER

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Personality ratings by research and care staff familiar with individual animals are a reliable and valid way to assess animal personality. However, many questionnaires are too long and thus too time-consuming for care staff, precluding their use in large samples. We sought to assess the inter-rater reliability (ICC[3,k]) and validity of a 12-item version of the Hominoid Personality Questionnaire. We collected ratings on 41 rhesus macaques (mean age = 4.59, 2.5 raters/animal) group-housed in three enclosures at the Oregon National Primate Research Center. Using published definitions of rhesus personality, we calculated scores for the dominance, confidence, openness, and anxiety dimensions. The inter-rater reliabilities of these dimensions were 0.78, 0.70, 0.41, and 0.38, respectively. We examined the correlations between these dimensions and a behavioral measure of rank (i.e., Normalized David's Scores) collected using 15-minute continuous focal observations (19.15 observations/animal). Higher rank was significantly ($p < 0.001$, $dfs=39$) correlated with dominance ($r = 0.68$), confidence ($r = 0.71$), openness ($r = 0.55$) and anxiety ($r = -0.60$). These results suggest that four personality dimensions derived from a brief questionnaire are reliable and demonstrate convergent validity. This questionnaire will be useful for studies of large samples or facilities with large populations where staff may be unable to complete longer questionnaires or collect detailed behavioral data due to time constraints.

247. SPATIAL STRUCTURE WITHIN GELADA (*THEROPITHECUS GELADA*) ONE-MALE UNITS AT GUASSA, ETHIOPIA

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This study aimed to identify some demographic and environmental factors related to spatial structure within foraging gelada (*Theropithecus gelada*) one-male units. High-precision GPS points were collected for each adult and subadult member of the unit during hour-long focal follows of each unit (9 units; 11–25 follows per unit; 4–9 adult/subadult animals per unit). Interpolation between GPS points yielded positions for all unit members at the same time. This study considered only times when a majority of unit members were foraging; 119 independent foraging times (>15 minutes apart) were obtained from 109 follows. Leader males were more towards the front of the group than adult or subadult females or follower males ($p \leq 0.01$ for all 3 comparisons). Adult females and leader males were more central than subadult females or

followers ($p < 0.05$ for all 4 comparisons). Foraging units were usually longer than they were wide; 75% of observations had the orientation of the unit's longest axis within 36 degrees of the travel direction. Mean inter-individual distance (IID) at each time was analyzed using a linear mixed model with random effect of unit ID. IID was smaller in areas of higher vegetation index (NDVI calculated from Landsat8 imagery) and closer to the sleeping cliffs (slope = -0.528 ± 0.175 for NDVI and 0.005 ± 0.001 for cliff distance, $p = 0.003$ and $p = 0.002$ respectively). Geladas forage farther apart when vegetation is sparser, perhaps to reduce competition.

248. TAKE THE MONKEY AND RUN

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The common marmoset (*Callithrix jacchus*) is a small, New World primate that is used extensively in biomedical and behavioral research. This short-lived primate, with its small body size, ease of handling, and docile temperament, has emerged as a valuable model for aging and neurodegenerative research. A growing body of research has indicated exercise, aerobic exercise especially, imparts beneficial effects to normal aging. Understanding the mechanisms underlying these positive effects of exercise, and the degree to which exercise has neurotherapeutic effects, is an important research focus. Thus, developing techniques to engage marmosets in aerobic exercise would have great advantages. Here we describe the marmoset exercise ball (MEB) paradigm: a safe (for both experimenter and subjects), novel and effective means to engage marmosets in aerobic exercise. Young adult marmosets were trained to run on treadmills for 30 minutes a day, three days a week. Our training procedures allowed us to engage marmosets in this aerobic exercise within four weeks, and subjects maintained this frequency of exercise for three months. These techniques should be useful to researchers wishing to address physiological responses of exercise in a marmoset model.

249. INVESTIGATING INFECTION RISK AND SOCIALITY: CENTRALITY INTERACTS WITH SEASONALITY TO PREDICT LICE LOAD IN FREE-RANGING FEMALE JAPANESE MACAQUES, *MACACA FUSCATA*

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Lice are socially transmitted ectoparasites, and potential vectors of disease. Individuals' infection risk depends partly upon their degree of contact with others. While grooming facilitates transmission of ectoparasites via body contact, it may constrain the spread of such organisms through removal. Japanese macaques conspicuously pick out louse eggs during grooming, a behavior we used to estimate individual lice load non-invasively. To investigate parasite/disease risk in relation to sociality, we tested the relationship between lice load and contact/grooming centrality with two opposing predictions: (1) central individuals harbor more lice because of their

numerous social contacts, (2) central individuals harbor fewer lice because of their frequency of being groomed. We studied 20 females of one group in Koshima, Japan. To account for variation in centrality and lice load, we controlled for female dominance rank, her reproductive state, and for season. Results show that centrality interacts with seasonality to predict female lice load (GLMM LRT(full/null): $D = 57.2$, $df=9$, $p < 0.001$): less central females harbored more lice than others in the mating (winter) and birth (summer) seasons but the relationship reversed during other seasons (e.g., degree:winter-spring = $\text{mean} \pm \text{SE} = 0.47 \pm 0.22$, $z = 2.16$; degree:winter-summer = $\text{mean} \pm \text{SE} = -0.14 \pm 0.29$, $z = -0.49$; degree:winter-fall = $\text{mean} \pm \text{SE} = 0.45 \pm 0.21$, $z = 2.16$). We link these results to the parasite and host biology and discuss the relationship between infection risk from socially transmitted parasites and sociality. Our lice load estimation constitutes a substitute to invasive methods for natural populations.

250. PRIMATES AND SNAKES, AN 80 MILLION YEAR DIALOG?

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Constrictors arose >100 mya and front-fanged venomous snakes ~50 mya, whereas primates originated ~75 mya and anthropoids ~46 mya. Natural history data document that serpents consume tree shrews, colugos, and >30 species of strepsirrhines, tarsiers, and anthropoids, including human hunter-gatherers (*Homo sapiens*); although no snakes specialize on primates, boa constrictors (*Boa constrictor*), Madagascan ground boas (*Acrantophis madagascariensis*), and reticulated pythons (*Malayopython reticulatus*) regularly eat them. Viperids and elapids defensively bite and sometimes kill primates, and among some forest people most adult males have survived one or more bites; lemurs, tarsiers, and anthropoids mob, kill, and sometimes eat snakes. These findings are consistent with three emerging generalizations: (1) Isbell's Snake Detection Theory, that as constricting predators and later venomous adversaries, snakes influenced the origin and radiation of primates, especially in terms of the neurobiology of vision and fear; (2) origins of front-fangs radically changed snake encounters with predators, such that visually- and acoustically-oriented, cognitively sophisticated adversaries promoted the evolution of defensive displays and mimicry; (3) as visual, acoustic, cognitive, and weapon-wielding adversaries, primates have affected snake evolution, including perhaps favoring spitting cobras, the only example of long-distance weaponry among all serpents. These bidirectional evolutionary relationships both challenge and inspire efforts to conserve snakes.

251. VOCALIZATIONS AS INDICATORS OF CHIMPANZEE WELFARE

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Chimpanzees respond to different situations with a variety of vocalizations. Vocalizations vary with state of mind, social context and environment. Five male chimpanzees, age 38 to 42 (mean=40) moved from a 343.74 m² foot outdoor playground area near other chimpanzees to a more isolated 12,000 m² forested habitat. All occurrences of vocalizations were recorded during instantaneous scan samples conducted for another study. Frequency, type of vocalization, and context were recorded. A total of 113 vocalizations were recorded (94 playground, 19 habitat). Vocalizations recorded included screams, food calls, hoo calls, laughing, waow alarm barks, pant

hoots, and pant grunts. No vocalizations of cry, whimper, pant, or cough threat were heard in either condition. The average frequency of hoo calls per individual, which are associated with distress, was higher in the playground (Mdn = 0.90) than in the habitat (Mdn = 0.10), N=5 pairs, $T = 0$, $p = 0.042$, $r = -0.64$, while pant hoots, which are associated with social excitement, tended to be higher in the playground (Mdn = 0.30) than in the habitat (Mdn = 0.00), N=4 pairs, $T = 0$, $p = 0.068$, $r = -0.58$. Vocalizations recorded in the playground often followed the fighting or vocalizing of nearby chimpanzee groups (68.63%). This preliminary study suggests that vocalizations could be explored as another possible indicator of chimpanzee welfare.

252. CAPTIVE GORILLA GORILLA AND PAN PANISCUS SHOW SIMILARITIES IN SOCIAL PROXIMITY IN CERTAIN BEHAVIORAL CONTEXTS BUT NOT IN OTHERS

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Similarities in habitat structure and feeding ecology among wild gorillas and bonobos have been suggested as a causal factor leading to comparable social characteristics. Gregarious relationships, especially among females, are thought to be facilitated by terrestrial herbaceous vegetation (THV) use in both species. As a result, both apes are commonly viewed as non-competitive foragers often feeding in large groups. However, few studies have directly compared the socio-ecology of the two species. For this study, we hypothesized that both species would spend more time in close proximity to conspecifics, rather than alone, across behavioral contexts. Individual focal follows on nine gorillas at Zoo Atlanta and 10 bonobos at the Jacksonville Zoo and Gardens were performed for a total of 46.1 hours of observation. Behavioral contexts were categorized as feeding, resting, and other and conspecific proximity was coded as alone or not alone. Data were analyzed for both sexes, and for just females of each species. The percentage of time each individual spent alone in each context was compared using a repeated measures ANOVA with species as the between subject factor. These data indicate a significant interaction between behavioral context and species $F_{(2,16)} = 9.44$, $p = 0.002$. Post-hoc analyses indicate that although both species spend similar amounts of time alone while feeding and resting, bonobos were more likely than gorillas to be in proximity of a conspecific outside of these two behavioral contexts.

253. TOTAL BLOOD VOLUME ESTIMATION IN RHESUS MACAQUES (MACACA MULATTA): ARE WE DOING THIS ALL WRONG?

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The use of mathematical formulas to regulate blood volume withdrawal in nonhuman primates (NHPs) is ubiquitous among research organizations using NHP models. Blood draw limits are usually expressed as an allowable percentage of total blood volume (TBV) taken over a given time period. TBV is typically calculated using a fixed ratio of blood volume to body weight. These fixed ratios used to estimate TBV vary considerably among research organizations. To help resolve this inconsistency, a study was conducted to determine TBV in each of 20 adult rhesus macaques (10M:10F). Two tracer substances of known volume and concentration were injected

simultaneously into the circulatory compartment of each anesthetized subject. The resulting dilutions of these tracers in subject plasma were measured in order to calculate plasma volume. TBV was then calculated from plasma volume and hematocrit. Weight and body composition by dual-energy x-ray absorptiometry were measured and then a body condition score (BCS) was determined for each subject. Our results demonstrated that the commonly used “10%:10% Rule” clearly over-estimated the TBV of all subjects. Moreover, subject body composition has a significant association with TBV not captured by the fixed ratio of blood volume per kg body weight formulas currently in use. We provide an equation that calculates TBV using the variables of weight and BCS, values that are often recorded during routine physical exams.

254. INTERACTION BETWEEN SOCIABILITY AND GROOMING NETWORK CENTRALITY ON ALOPECIA IN CAPTIVE RHESUS MACAQUES (*MACACA MULATTA*)

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Socio-psychological factors (e.g., personality and social environment) are critical in health and welfare. However, their effects on alopecia are rarely considered. To understand whether or not personality and social environment interact to affect alopecia, we examined effects of sociable personality, grooming network centrality and their interaction on alopecia in 48 rhesus macaques in a mixed age and sex social group housed in a ½-acre outdoor enclosure at California National Primate Research Center for 6-week period. Personality ratings were based on 12 10-min focal observations. Sociability was measured by averaging ratings on affiliative, warm, popular, tolerant and not solitary (Cronbach’s alpha = 0.80). Weighed undirected grooming network was constructed by scan-sampling of grooming interactions. Centrality measures included betweenness, average neighbor degree, eigenvalue, alpha centrality and Bonacich power. Alopecia was scored as presence ($\geq 25\%$) or absence ($< 25\%$) of hair loss. Binomial regression was used to predict alopecia using Sociability and its interaction with each of the centrality measurements respectively. Demographic variables were not significant predictors. The interaction between Sociability and grooming network betweenness significantly predict alopecia presence ($B = 2.10$, $p < 0.05$). Sociability was protective against alopecia only for individuals with low betweenness. For individuals with high betweenness, sociability was associated with a greater likelihood of developing alopecia. No effects of other centrality measures were found. This suggests that personality and social environment interactions play an important role in alopecia.

255. DETECTING AND REACTING TO SNAKES: THE PREEMPTIVE STRATEGIES OF PRIMATE SNAKE AVOIDANCE

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Snakes have been important predators of primates since the inception of the order [Isbell 2006]. Accordingly, primates, both human and non-human, tend to react strongly to snakes. Psychologists have investigated these reactions in computer-based search tasks that address questions related to our ability to detect snakes quickly. These studies have demonstrated that both human and

macaque subjects have quicker reaction times to coiled objects than to a variety of other objects, suggesting that serpentine shapes are given perceptual precedence in primate visual systems [LoBue & DeLoache 2011]. Outside the laboratory, primatologists have reported anecdotes, systematic observational data, and results of field experiments that highlight the roles of visual vigilance, referential alarm calls, and other behavioral strategies (e.g., sleeping site selection) that contribute to snake detection and avoidance [Ramakrishnan et al., 2007]. These data indicate that primates tend to react to snakes in accordance with the degree of threat they pose, but they do so in ways that are sometimes unexpected or difficult to reconcile with other data. Here I summarize the strengths and limitations of laboratory and field methods as related to studies of primate-snake (or snake-like stimuli) encounters, the general conclusions from these studies, and the important questions yet to be answered about the ways that primates cope with the threats posed by snakes.

257. IS THE SPATIAL STRUCTURE OF VERVET MONKEY (*CHLOROCEBUS PYGERYTHRUS*) TROOPS DETERMINED BY RANK AND SOCIAL INTEGRATION?

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There are strong theoretical and empirical reasons to believe that more dominant and/or more socially integrated animals should occupy the spatial centre of social groups. We test this hypothesis using spatially explicit data collected from two free-ranging vervet monkey troops (Group size: PT = 14; RBM = 28). By deploying many data collectors simultaneously, we obtained 147 independent samples (NPT = 74; NRBM = 73) in which the GPS coordinates of all troop members were determined within a 10-minute window. After correcting for temporal offset, we identified the spatial centre for each sample and calculated each animal's distance from it. We determined dominance from records of agonism and indexed social integration as directed network centrality, derived from grooming interactions. After standardisation, we ran a linear mixed model for adults of each sex, with individual identity as a random effect, and troop size, rank and social centrality as predictors of distance from the group centre. Despite moderate positive correlations between dominance rank and social centrality for males in both troops ($r_{PT} = 0.79$; $r_{RBM} = 0.64$) and females in one ($r_{PT} = 0.74$; $r_{RBM} = 0.09$), there was no indication that dominance or social centrality, or their interaction, underpinned spatial structure (Females: $p_{Rank} = 0.35$, $p_{Centrality} = 0.12$, $p_{Rank*Centrality} = 0.19$; $R^2 = 0.07$. Males: $p_{Rank} = 0.92$, $p_{Centrality} = 0.55$, $p_{Rank*Centrality} = 0.89$; $R^2 = 0.03$). There was no effect of troop size. We conclude that explanations for expressed spatial structure should be sought in habitat constraints and the dynamics of individual movement.

258. SUBCORTICAL VISUAL SENSITIVITY TO SNAKE STIMULI IN THE PRIMATE BRAIN

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There is ample evidence implicating the colliculo-pulvinar visual pathway in the detection of affective stimuli. This pathway, which is classically associated with visual alertness and attention shifts, extends from the retina to the superior colliculus and the pulvinar nucleus. Recently, we found that both areas are sensitive to snake visual stimuli [Maior et al., 2011; Le et al., 2013].

Neurons in the medial pulvinar not only respond faster and stronger to snake images, but their activity is likely to code the level of threat depicted in those images [Le et al., 2014]. Also, low spatial filtering did not reduce neuronal firing, which is consistent with colliculo-pulvinar involvement. These results are indicative of the evolutionary importance that visual snake detection may have had in the evolution of primates. The scope of our line of investigation will be presented in the light of converging evidence from neurobiological studies.

259. LOW-LEVEL VERSUS SERIOUS AGGRESSION IN FOOD RESOURCE AND NON-FOOD RESOURCE CONTEXTS AND GROUP STABILITY IN CAPTIVE RHESUS MACAQUES (*MACACA MULATTA*)

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Matriline relatedness can decrease over time, resulting in fragmentation that is associated with social instability and serious aggression in rhesus macaques. We assessed whether experimental removal of matriline fragments (N=18 individuals) to increase relatedness was associated with reduced serious aggression and whether this varied by context (food resource versus other). Conflict event data among 103 subjects aged 3-29 from a captive rhesus group were recorded during a 7-week pre-removal, 7-week post-removal, and 7-week follow-up phases from March through July 2013. Events were categorized as either low level aggression (threats, pushes, short chases) versus more intense contact aggression (long chases, wrestling, pinning, and biting). We fit a mixed-effects binomial regression model of aggression frequency per individual per study phase (N=18896 records). The best fit model showed that the probability of serious aggression during an event did not change between pre-removal and post-removal phases (post vs. pre: Beta = 0.07, p = 0.16), but decreased in the follow-up phase (follow-up vs. pre: Beta = -0.15, p = 0.009). An interaction of context and dominance certainty showed individuals with more certain dominance used more serious aggression in non-food contexts (dominance certainty: Beta = 0.93, p < 0.001; food vs. other context: Beta = 0.05, p = 0.88; dominance certainty × food: Beta = -1.08, p = 0.002), but not in food contexts. This suggests that in stable groups, food contexts will have more low-level aggression associated with maintaining stable relationships.

262. AN ECOLOGICAL VALIDATION OF THE NOVELTY SEEKING TRAIT IN WILD VERVET MONKEYS (*CHLOROCEBUS PYGERYTHRUS*) IN SOETDORING NATURE RESERVE, SOUTH AFRICA

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Consistent individual differences in novelty seeking behavior have been studied intensively in captive vervet monkeys, where they are known to have a strong genetic basis. Although hypotheses regarding the behavioral ecology of this variation exist, these have not been widely tested in natural populations. Because the development and expression of personality phenotypes is known to be influenced by environmental factors, both the construct and the ecological validity of novelty seeking in wild vervets need to be evaluated. I tested responses of 40 adult and subadult vervet monkeys, *Chlorocebus pygerythrus*, to a variety of novel objects, in Soetdoring Nature

Reserve, South Africa. For tests where individuals differed in their intensity of exploratory behavior, novel object exploration (NOE) scores were repeatable ($r = 0.37$, $p = 0.003$) across tests, demonstrating consistency in novelty seeking in a wild population. Mean NOE scores were further positively correlated with the frequency of inspection of naturally occurring snakes, providing an important ecological validation. Males had higher NOE scores than females, and subadults had higher scores than adults. Although sex differences in novelty seeking have not been found in studies of captive vervets, the demographic properties of both NOE and snake inspection scores in this study are consistent with findings in humans, where higher sensation-seeking among males is well documented. Supported by the Leakey and Wenner-Gren Foundations, ASP, IPS, NYU and AAUW.

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