Abstract # 1

DEXTERITY AND FLEXIBILITY IN TERMITE FISHING BY ADULT FEMALE CHIMPANZEES (*PAN TROGLODYTES TROGLODYTES*) IN THE GOUALOUGO TRIANGLE, REPUBLIC OF CONGO

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Study of manual actions during tool use among wild primates is essential for understanding the evolution of the manual dexterity and flexibility that underlie these skilled behaviors. We describe how chimpanzees in the Goualougo Triangle use herbaceous probes to fish for termites from labyrinthine, epigeal nests. Using remote video footage (30 fps), we coded the fishing techniques of seven female chimpanzees (five adults and two sub-adults). With a coding scheme of 20 actions and 70 modifiers, we analyzed frame by frame 16 clips lasting approximately two minutes each. We recorded hand position, grips and readjustments, oscillations of the inserted tool, the location of the insertion point with respect to eye level, and the form of feeding actions for 410 attempted insertions, of which 334 succeeded. All the chimpanzees used a wide variety of actions, and we did not detect clear individual patterning or differences in success rates. Insertions at eye level (vs. above or below eye level) were more numerous (M = 29 vs. 15, NS, Wilcoxon signed ranks). Chimpanzees occasionally aided insertion with a second hand (M = 28%, range 5 – 50%) and occasionally failed to insert the probe (M = 24%, range 12 - 37%). Our findings indicate that experienced chimpanzees manage the fishing task flexibly, often using complementary bimanual actions, and suggest that insertions at eye level are preferred.

Abstract # 2

VALIDATION OF EXPERIMENTAL METHODS TO MEASURE EXPLORATION IN COMMON MARMOSETS (*CALLITHRIX JACCHUS*)

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Protocols designed to measure exploratory behavior often involve exposing animals to novel foods, objects, or environments. However, the assumption that these assays actually measure a single dimension of behavior is seldom tested. Here we exposed 46 (39 female, 7 male) captive common marmosets (*Callithrix jacchus*) to novel foods and objects to systematically compare behavior across contexts. We recorded individuals' responses to experimental stimuli and generated investigation, activity, and agitation scores for each animal. We used intraclass correlation coefficients to measure within-individual repeatability of behavior and Generalized linear mixed models to examine the relationships among different behavior scores. Preliminary results reveal that monkeys responded consistently toward objects (link scale $r = 0.32$, $p = 0.05$) but not foods (link scale $r = 0.010$, $p = 0.50$). Levels of investigation, activity, and anxiety were independent. Activity was positively correlated across contexts ($\rho = 0.795$, $p = 0.0007$), whereas agitation and investigation were not ($\rho = -0.23$, $p = 0.43$, $\rho = 0.15$, $p = 0.60$, respectively). These results indicate that marmosets exhibit inter-individual differences in repeatability of behavior and this measure depends on context. What is more, marmosets may exhibit behavioral syndromes. Lastly, these results corroborate previous findings that suggest that behavioral assays should be tested for independence in order to confirm behaviors of interest are actually being measured.

Abstract # 3

CAPTIVE CAPUCHIN MONKEYS (*CEBUS APELLA*) BEHAVE PROSOCIALLY MORE OFTEN WITH STRONG AFFILIATIVE PARTNERS DURING A FOOD SHARING TASK

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Prosociality refers to the behavior of one animal that benefits another. The influence of the strength or weakness of the affiliative relationship between partners on prosociality remains poorly understood. We tested brown capuchin monkeys' tendency to behave prosocially during a food-sharing task in which each individual was paired with a socially strong partner and socially weak partner. Social index scores, which are based upon the duration of affiliative behavior between individuals, were used to determine socially strong and socially weak dyads. During testing, one subject was secluded in a compartment containing food, and a partner was confined to an adjacent compartment. Subjects could choose to open an interconnecting door by removing a lock, which could only be accessed by the subject. If the subject opened the door, the partner could enter the subject's compartment and access the food. Of four adult females, two females opened the door more often than expected for a socially strong partner and refrained from opening the door more often than expected for a socially weak partner, Subject 1's chi-square(1,24)= 8.0, p=.005; Subject 2's chi-square(1,24)=20.3, p<.001. Results provide evidence that stronger affiliative relationships are associated with increases in prosocial behavior. Social index scores are a quantitative measurement of relationship strength and may provide more accurate assessment of the influence of social dynamics on prosociality than qualitative measures such as kinship.

Abstract # 4

EFFECTS OF AGE, SEX, AND REPRODUCTIVE STATE ON INJURY IN PHAYRE'S LEAF MONKEYS

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Primate aggression is an expression of both the need for resources and the costs of potential injury. Therefore, individuals with greater resource needs (e.g., cycling and pregnant females) may engage in aggression and risk injury more than individuals for whom injury would mainly be costly (e.g., lactating females and older individuals). Here we investigated how injuries in Phayre's leaf monkeys (*Trachypithecus phayrei crepusculus*) were related to age-sex class and female reproductive state. In this species, young infants are frequently subject to allomothering, which might increase their risk of injury. Furthermore, adult female rank is age-inversed and mainly dependent on individual competitive ability, suggesting that injury risk should be highest in young adults. We used GLMMs to test two years of data on the monthly occurrence of injury (n=64) in two groups at the Phu Khieo Wildlife Sanctuary, Thailand. In the larger group only, young infants experienced a greater proportion of months with injury (β=-0.67; p<0.001). Among adult females, there was a trend toward more injury in young females in the smaller group (β=1.25; p=0.07) and during preconception in the larger group (β=-1.21; p=0.03). Our findings suggest that dependent infants and young adult females experience greater injury risk and that group composition may influence these patterns. Whether injury risk in infants is related to allomothering needs further investigation. Supported by NSF, the Leakey Foundation, and ASP.

Abstract # 5

A COMPARISON OF DESENSITIZATION TECHNIQUES TO TRAIN RHESUS MACAQUES TO TAKE FOOD FROM A HUMAN

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Some primates express fear of or avoid interaction with humans, including accepting food. Counter-conditioning training designed to reduce fear and increase the acceptance of food from a person's hand can reduce the stress an animal experiences and serve as a foundation for training other behaviors through positive reinforcement techniques. Counter-conditioning techniques were compared among 16 rhesus macaques (*Macaca mulatta*) being taught to accept food from a person's hand. Animals were randomly assigned to the control, desensitization, positive reinforcement, or negative reinforcement condition. The positive and negative reinforcement conditions combined desensitization with reinforcement components, including either giving additional food or leaving the room when the animal met criteria for accepting food. Although a Kruskal-Wallis test showed no significant difference in the rate at which subjects progressed through training across the conditions ($H=5.974$, $p=.113$) with our modest sample size, visual examination of the data revealed interesting trends. There seem to be more consistent training results in the positive reinforcement condition with three of four animals consistently accepting food directly from the person's hand at the end of eight training sessions, compared with zero or one animal in each of the other conditions. Additional subjects and other methodological improvements could strengthen the findings, but these preliminary results are encouraging as they indicate some of these techniques may be successful in efficiently reducing fear in rhesus macaques.

Abstract # 6

COPULATION CALLS OF FEMALE TAIWANESE MACAQUES (*MACACA CYCLOPIS*) AT NANHUA AREA IN SOUTHERN TAIWAN

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Female calls are loud and distinctive during mating, especially in the primates. It may be relevant to female mating strategies. Female Taiwanese macaques (*Macaca cyclopis*) make calls during mating, but the pattern of copulation calls hasn't been clearly reported. Therefore, we were aimed to investigate copulation calls of female Taiwanese macaques, and to examine how the calls associated with their mating activities. This study was conducted on habituated and provisioned groups in southern Taiwan, over which mating activities of 20 identified adult females were observed by focal animal sampling. During each focal sample, mating activities of the focal animal were recorded for who initiate mounting, whether males ejaculate, the mounting series, and whether and when females call during the mating activity. In the mating season from October 2016 to February 2017, we observed the monkeys for about 500 hours and recorded 315 mating events, including 257 single-mounting and 58 multi-mounting series. Female copulation calls occurred in 50.7% of the mounting events. Copulations were mostly initiated by males (94.0%). Females called more frequently after dismounting (post-copulation calls, 67.5%), and they made calls more frequently if ejaculation occurred ($x2=58.39$, $p<0.0001$). Furthermore, females called more frequently during mounting when ejaculation occurred (with ejaculation:57.5% vs. w/out ejaculation:5.8%, Fisher exact test, $p<0.001$). The results show that female Taiwanese macaques make post-copulation calls and these calls are highly associated with ejaculation.

Abstract # 7

VALIDATION OF EXPERIMENTAL METHODS TO MEASURE EXPLORATION IN CAPTIVE GOLDEN LION TAMARINS (*LEONTOPITHECUS ROSALIA*)

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Assays of exploratory behavior often involve exposing animals to novel foods, objects, or environments. However, the assumption that such protocols actually measure a single dimension of behavior is seldom tested. Here we exposed 27 (14 female, 13 male) captive golden lion tamarins (*Leontopithecus rosalia*) to novel foods and objects to systematically compare behavior across contexts. We recorded individuals' responses to experimental stimuli and calculated investigation, activity, and agitation scores for each animal.

We used intraclass correlation coefficients to measure within-individual repeatability of behavior and generalized linear mixed models (GLMM) to examine the relationships among behavior scores. Preliminary results reveal that monkeys responded consistently toward foods ($r = 0.47$, $p = 1.22$ e-05) but not objects ($r = 0.02$, $p = 0.27$). Those exhibiting the greatest levels of investigation also were the most active (GLMM: $\beta = 0.04 \pm 0.01$, $t_{25} = 3.82$, $p < 0.001$). However, investigation and agitation was unrelated (GLMM: $\beta = 0.01 \pm 0.01$, $t_{37} = 0.39$, $p = 0.70$). Activity was positively correlated across contexts ($\beta = 0.51$, $p = 0.02$), but agitation and investigation were not ($\beta = 0.02$, $p = 0.94$; $\beta = 0.16$, $p = 0.48$, respectively). These results indicate that tamarins differ in the repeatability of behavior and that some behaviors are correlated. These results also confirm that assumptions of independence should be tested for behavioral assays.

Abstract # 8

CAPTIVE HAMADRYAS BABOONS (*PAPIO HAMADRYAS HAMADRYAS*) EXHIBIT RITUALIZED POST-CONFLICT DISPLACEMENT BEHAVIOR

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Displacement behavior is characterized by irrelevance to the situation in which it takes place and, as it often occurs in stressful contexts, is used as a behavioral indicator of anxiety. While body care activity is the most commonly reported displacement behavior in primates, object manipulation is also observed following tense situations. This study explored the social contexts in which a manipulation displacement behavior occurred in a captive group of hamadryas baboons. Previous research established digging through gravel substrate as a displacement behavior occurring after aggression in this group. Some individuals perform similar digging motions when housed indoors on a non-manipulatable surface. Continuous behavior sampling of aggression/submission (threats, bites, screams and barks) and indoor digging ("swiping") was conducted. Over 22.17 hours, 560 aggressive/submissive interactions and 111 swiping bouts were observed. Of the 14 baboons, eight were observed swiping. Across these individuals, swiping occurred significantly more often within two minutes of aggressive/submissive interactions than during two-minute intervals not preceded by agonistic behavior (paired samples permutation test, two-tailed, $p<.01$). Results suggest that the indoor swiping is a ritualized version of the outdoor digging displacement behavior and is an indicator of post-conflict anxiety in this group. Because this displacement behavior cannot be confused with a functional response, it can serve as a valuable tool to pinpoint anxiogenic social events.

Abstract # 9

BEHAVIOR DIFFERENCES IN A SILVERBACK IN THE PRESENCE OF MALE VS FEMALE CONSPECIFICS: A CASE STUDY

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In the course of introducing a new silverback to an existing family group of zoo housed lowland gorillas (*Gorilla gorilla gorilla*; n=10), keepers occasionally mentioned that the male's indoor behavior appeared to vary depending on which of several other animals were also present at the time. Systematic observations were conducted in May and June of 2016 to see if this was, in fact, happening. Approximately 16 hours of focal animal samples were collected across four conditions. Summary descriptive measures revealed a clear difference between one condition and each of the remaining three: The silverback spent much more time in both locomotion (23.5% of total observation time) and manipulation (37.8%) when three adult females were indoors near him and two other young adult males were outdoors than when the females were outdoors and the other males were indoors (4.6% and 8.0%, respectively), or when both females and other males were inside, either early (4.6% and 23.4%), or late (3.8% and 20.6%). Further, this behavior pattern differed from that of another silverback and from patterns averaged across all other group members who were present. Although they seem somewhat counterintuitive, these results can be related both to the reported behavior of silverbacks in the wild and the rearing history of this particular male. The results also confirm the accuracy of the anecdotal observations made previously by his keepers.

Abstract # 10

TOSSING AND TURNING THROUGHOUT THE NIGHT: A LOOK AT CHIMPANZEE SLEEP PATTERNS USING OVERNIGHT CAMERAS

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Most primate behavior studies tend to start when the animals wake in the morning and end when they go to sleep for the evening. As such, there is relatively little known about what goes on at night for diurnal primates, such as great apes. Given that quality of sleep is thought to influence cognition and possibly welfare in both humans and nonhuman primates, assessments of sleep behavior for captive apes may be of particular importance. We studied the nighttime activity, a proxy for sleep quality, of a group of six adult chimpanzees (*Pan troglodytes*) housed at Lincoln Park Zoo. Observations were taken from video recordings that spanned from evening nesting time (approximately 5pm) to morning waking time (approximately 6am). To date, 340 hours of focal data have been scored with five-minute intervals recording body movement and posture changes. Movement rate was consistent throughout the night and across individuals; 64.3±2.3% of visible scans revealed movement relative to the previous scan with little variation throughout the night (hourly range 55.8-69.5%). Despite frequent movement, chimpanzees were typically laying down (99.2% of visible scans). These results suggest that these chimpanzees maintain a consistent yet moderate level of activity throughout the night. Further investigations will elucidate the factors that affect sleep patterns for apes and provide useful information to aid managers caring for captive populations and promoting positive animal welfare.

Abstract # 11

MEASURING AFFECTIVE RESPONSES TO INEQUITY IN CAPTIVE CHIMPANZEES (*PAN TROGLODYTES*), ORANGUTANS (*PONGO ABELII*) AND CAPUCHIN MONKEYS (*CEBUS APELLA*)

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Inequity aversion is well documented in humans. Even young children show a negative behavioral reaction to inequity, despite accepting the lesser reward. Some non-human primates (NHPs) also show inequity aversion, but not all. One possible explanation is that in NHPs, reactions are operationalized as refusal to complete a task or accept a food reward, but this is costly, and like children, primates may notice inequity even when they do not refuse. To explore this, we coded video tapes of three species of NHPs (seven pairs of chimpanzees, four pairs of orangutans and three pairs of capuchin monkeys) for differences in levels of arousal (i.e., pacing, threats, banging) as a proxy for negative affect. We coded video tapes of the species on three conditions: inequity, equity control and individual contrast. We found that levels of arousal did vary. Capuchin subjects showed increased arousal in the inequity condition ($z=-1.33$, $p=0.04$) compared to the contrast and equity conditions. Interestingly, chimpanzee subjects showed the opposite pattern, with increased arousal in the equity condition ($z=2.46$, $p=0.014$). Consistent with their lack of refusals, orangutan subjects showed little variation across the conditions. These results indicate complex relationship between noticing inequity and refusals.

Abstract # 12

THE SOCIAL DYNAMICS OF OLD, FREE-RANGING RING-TAILED LEMURS AT THE DUKE LEMUR CENTER

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There has been little emphasis on the social and behavioral strategies old primates might use to meet the challenges of senescence while maintaining social engagement, such as assuming a group role like navigator. Understanding how old primates maintain sociality can reveal how behavioral flexibility might have facilitated an increase in longevity within the order. Using focal sampling of old (N=9, 10+ years) and prime and pre-prime (N=6, <10 years) *Lemur catta* at the Duke Lemur Center, activity budgets, social interactions, and group traveling information were recorded and compared from May to August of 2016. No significant difference in social contact time was found between old and young females (ANOVA, $F=3.8$, $p>.05$) or between old and young males (ANOVA, $F=4.5$, $p>.05$). Therefore, older individuals seem to maintain sociality, consistent with other research on aged primates. No significant difference between leading behavior between female age groups (ANOVA, $F=0.8$, $p>.05$) was found. However, older males seem to lead group movements significantly more often than younger males (ANOVA, $F=9.6$, $p=0.0361$). This suggests that in a captive, provisioned environment older males might function as a navigator during travel. Future work with sociality in aged primates must account for differential strategies among individuals based on key factors such as rank, matriline, and sex.

Abstract # 13

FALSE DUSK BUT NOT VISITOR NUMBERS INFLUENCE EVENING RETIREMENT BEHAVIORS IN ZOO-HOUSED CHIMPANZEES (*PAN TROGLODYTES*)

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When wild chimpanzees nest for the evening is related to environmental factors such as temperature and weather. In zoos, chimpanzees experience additional potentially influencing factors, such as the presence of visitors, yet the relative influence of these elements on chimpanzee evening retirement behaviors is unknown. Here, retirement behaviors were defined as nest building, sleeping, or inactivity. We investigated if and how the time of day, weather, and crowd size impacted the evening retirement timing of a mixed-sex chimpanzee group (N=6) housed at Lincoln Park Zoo, Chicago, in an exhibit with abundant natural light and daily exposure to zoo visitors. The chimpanzees' behaviors were recorded via 10-minute focal sessions using 30-second intersample intervals. We analyzed 86 hours of observational data recorded between 2pm and 5pm each weekday from March 2015 to February 2016. The proportion of time chimpanzees spent performing retirement behaviors was best explained by an hour x weather interaction ($p<0.001$): the proportion of retirement behaviors increased with time and was higher in the 4pm hour when it was overcast. Adding crowd size did not improve the model ($p>0.05$), suggesting that false dusk (low levels of light due to cloud cover) but not visitor numbers influenced retirement. Findings contribute to existing theories regarding the importance of exhibit design and its possible negation of crowd effects on behavior.

Abstract # 14

BEHAVIORAL CORRELATES OF LONG CALLS IN MANTLED HOWLER MONKEYS

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This study tests the spacing hypothesis as an explanation for long calling in mantled howler monkeys (*Alouatta palliata*). The spacing hypothesis suggests that howler monkeys use their long calls (howls) to communicate their location to neighboring groups so that the various groups can space themselves out optimally in a feeding area and avoid costly agonistic encounters. Although the spacing hypothesis is well-established, little is known about the underlying cognitive and communicative mechanisms. This study measured activity budgets before and after in-group and out-group howls to test whether howling is associated with an overall increase in activity. I collected 17.5 hours of behavioral data at Maderas Rainforest Conservancy's field station at La Suerte, Costa Rica. Using modified scan samples, I measured overall activity budgets for the monkeys, then compared these baseline levels to observations taken within 5 and 10 minutes after a neighboring group's long call. I also compared them to observations taken in the 5 and 10 minutes preceding a call from the focal group. Neighboring long calls had no significant effect on activity budgets in either 5- or 10-minute tests (Mann Whitney U-Test, $p>0.2$ for all relationships). Based on these

findings, howler monkeys do not appear to respond to the calls of their neighbors by changing their activity budgets, nor do changes in the activity budget precede calling.

Abstract # 14

NESTING BEHAVIOR IN ZOO-HOUSED ORANGUTANS (*PONGO* SPP.)

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Like their wild counterparts, zoo-housed orangutans make nests daily when given adequate materials, suggesting that the primary function of orangutan nests is for rest and sleep, and that orangutan nests are more similar to human beds than to the more permanent nest home bases of birds and other mammals. As part of a larger study comparing the nesting behavior of six orangutans at the Smithsonian's National Zoo with wild orangutan nesting behavior, we disseminated a survey throughout the Association of Zoos and Aquariums with an aim to document the use of preferred nesting materials, locations, and innovative behaviors observed in the nesting context in zoo-housed orangutans. We present a summary of survey results, indicating the presence of at least one behavior that occurs only rarely (7% of the 31 facilities surveyed), as well as several universal patterns of nesting behavior across institutions. We also report an interesting innovative behavior in the nesting context that appears to be engaged in more often by females than by males ($X2 = 4.390$, $df = 1$, $p = 0.036$).

Abstract # 15

ANTI-PREDATOR BEHAVIOR AND DISCRIMINATIVE ABILITIES: PLAYBACK EXPERIMENTS WITH FREE-RANGING EQUATORIAL SAKI MONKEYS (*PITHECIA AEQUATORIALIS*) IN THE PERUVIAN AMAZON

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The anti-predator behaviors of free-ranging groups of equatorial saki monkeys (*PITHECIA AEQUATORIALIS*) were recorded in the Área de Conservación Regional Comunal Tamshiyacu Tahuayo in the Peruvian Amazon to determine whether individuals responded in predator-specific ways to calls of aerial and terrestrial predators. Previous studies have shown that several species of Old World monkeys possess these discriminative abilities, but few have explored this question in New World monkeys. The ability to recognize predators and to respond appropriately is important for survival. Thus, we predicted that equatorial saki monkeys should respond in predator-specific ways, both vocally and behaviorally, to aerial and terrestrial predators. To investigate this, we simulated the presence of predators by playing recordings of harpy eagle calls (*Harpia harpyja*; an aerial predator) and ocelot growls (*Leopardus pardalis*; a terrestrial predator) to wild saki groups. Response variables measured included individuals' vocalizations, movement, and gaze orientation. Between July-August 2016, we conducted 24 playback trials on 16 individuals. X2 goodness of fit tests revealed that alerted or predator-specific responses were given more often than no response at all following the playbacks of predator calls (alpha = 0.05; eagle call: $p = 0.021$; ocelot growl: $p = 0.035$). Thus, while additional confirmation is needed, our data provide preliminary evidence that saki monkeys possess predator specification capabilities. Support provided by the American Society of Primatologists and Winthrop University Research Council.

Abstract # 16

ACTIVITY BUDGET AND ALOPECIA IN CAPTIVE CHIMPANZEES (*PAN TROGLODYTES*): IMPACT OF SEX, AGE, AND GROUP SIZE

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The purpose of this study was to investigate the influence that age, sex, and group size has on the activity budgets and coat conditions of captive socially-housed chimpanzees. Four 15-minute samples of behavioral data were collected quarterly on 128 chimpanzees (68 females) aged 5.6-51.3 years (M=26.8) that were housed in groups ranging from 2-6 individuals (M=3). The data were collected using an instantaneous point sampling technique. Categories of behavior included aggression/arousal, social, active, rest, eat/drink, self-directed, object-directed, and abnormal. Alopecia was scored separately using a 6 point scale ranging from 0 (no alopecia) to 5 (severe alopecia). The most common behavior was rest; the least common were aggression/arousal and abnormal. The average alopecia score was 1.3 (range: 0-5). Using sex, age, and group size as independent variables, a linear regression was conducted on the behavior categories and the alopecia scores. Larger social groups were more likely to engage in social interactions ($b=0.718$, $p<0.005$) and less likely to engage in object-directed behavior ($b=-0.211$, $p<.05$). Older animals exhibited more abnormal behavior ($b=0.084$, $p<0.005$) and less object-directed behavior ($b=-0.051$, $p<0.001$), and males exhibited more self-directed behavior ($b=0.754$, $p<0.05$). There was no effect of the independent variables on alopecia. An understanding of the influence of group size, sex, and age on chimpanzee behavior and alopecia will allow us to better tailor behavioral management to individualized needs. Supported by P51OD011133.

Abstract # 17

FEMALE-FEMALE AGGRESSION IS HEIGHTENED DURING CONSORTS WITH PREFERRED PARTNERS IN OLIVE BABOONS (*PAPIO ANUBIS*)

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There is evidence that female choice and male-female friendships play important roles in reproduction in olive baboons (*Papio anubis*). Strategies that limit competition among females for access to mates and friends, like directing aggression towards potential competitors, may have significant fitness benefits. To begin testing the role of female-female aggression in male-female associations we completed a 14-month study at Gombe Stream National Park, conducting focal follows (n=666) on cycling female olive baboons (N=19) and collecting fecal samples (n=612) to assess ovulatory status. Female baboons exchanged 676 agonistic interactions (excluding approach-retreat interactions, which were used to determine rank relationships) with other females in their social groups over the course of the study. Females initiated and received lower rates of aggression during consorts than outside this mate-guarding context (Mann-Whitney U test, initiated $U=-2.615$, $p=0.009$; received: $U=-7.438$, $p<0.001$), indicating the consort partner may insulate females from these aggressive encounters. Females that were ovulating and in consorts directed higher rates of aggression towards other females ($U=2.758$, $p=0.006$), specifically targeting lactating females rather than other cycling ($U=2.301$, $p=0.021$) or pregnant females ($U=-3.136$, $p=0.002$). Finally, females were more aggressive when in consorts with preferred partners compared to those who were not preferred ($U=2.301$, $p=0.021$). We argue these data indicate female olive baboons preferential direct aggression towards other females to avoid disruption of bonding with potential sires of offspring.

Abstract # 18

THE EFFECTS OF A SEEMINGLY DISRUPTIVE AIR SHOW ON THE BEHAVIOR OF TWO SPECIES OF ZOO-HOUSED APE

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Unexpected loud noises can negatively impact the behavior of captive animals, but little is known about the impact of disruptive noise on great apes. We compared the behavior of gorillas (n=17) and chimpanzees (n=14) at the Lincoln Park Zoo (Chicago, IL) in relation to the annual Air and Water Show, during which very loud aircraft regularly fly above their enclosures. We compared 308 hours of behavioral data over nine years (2005-2013) on the two species prior to, during, and after the event. Chimpanzees displayed no significant difference in behavior rates before, during, or after the event. Gorilla behavior however differed significantly

during the week of the air show; compared to a baseline period prior to the event, gorillas showed higher rates of agonism (t78=2.23, p=0.03) and higher rates of prosocial behavior (t78=-2.23, p=0.03), but lower rates of abnormal behavior (t78=-2.36, p=0.02). These results suggest that the two species of apes react differently to noise-related disruptions and that gorillas in particular may be sensitive to sporadic loud noise. While little can be done to prevent some environmental disturbances such as this show, managers can use data like these to inform strategies designed to buffer animals from behavioral disruption.

Abstract # 19

SIRE CONCEPTION RATE IN MALE RHESUS MACAQUES (*MACACA MULATTA*) ALTERNATED BETWEEN HAREM GROUPS

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The Johns Hopkins University began developing an SPF Indian-origin rhesus macaque breeding colony in the early 1990's to provide the University with a source of SPF Indian-origin rhesus. A shortage of breeding males resulted in harem groups either being combined, which often resulted in severe aggression and injuries, or harems went without a breeding male, negatively impacting the overall birth rate. To increase the percentage of females with access to adult males, we established a procedure of allowing five males to each access two harems throughout the breeding season. Our newly established procedure eliminated the need to combine harem groups and allowed greater amounts of females access to males; however, it was unclear whether this rotation would affect each male's "sire conception rate" (SCR). Here we compared each male's SCR for one to three years prior to establishing the alternating schedule to their SCR over two to three years during which each male was given access to two harems. The mean SCR in single-harem breeding seasons was 70.1% and 69.9% during alternating-harem breeding seasons, a statistically insignificant difference (p=0.974). SCR was stable across both conditions despite males accessing an average of 4.4 additional females during alternating-harem breeding seasons, producing an average of 4.2 additional offspring. This demonstrates that alternating males between harems is an effective breeding management tool in the face of limited male stock.

Abstract # 20

FORMATION OF STABLE RHESUS MACAQUE (*MACACA MULATTA*) BACHELOR GROUPS FOR FUTURE BREEDING

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The YNPRC routinely introduces novel breeder males to rhesus groups to increase genetic variability, avoid inbreeding, and to decrease the female to male ratio. The following criteria are considered when selecting future breeding males: 1)parentage, 2)MHC characterization, 3)affiliation/aggression levels, and 4)clinical history. Additionally, since male social bonds and breeding competence can both affect reproductive success, we describe two unique strategies employed at Yerkes that enhance these characteristics. Strategy 1 includes removal of sub-adult males (~3yo) from natal groups concurrently with their outgoing, unrelated and compatible resident breeder male(s). Strategy 2 involves removal of juvenile males (~2-3yo) from multiple natal groups, and then introduction to reproductively-experienced adult mentor male(s). Our previous data suggest that it is critical to allow the male groups, in either strategy, at least one year to stabilize prior to the introduction to females. We find that introduction first to small groups of females, usually consisting of a single matriline or a few unrelated females, limit social influences and enables smoother transition to more complex female groups later. Past methods rarely involved a mentorship/bonding phase or transitions into complex breeding groups. Preliminary observations demonstrate that these strategies facilitate male introduction success and decrease overall group unrest. While this is a new management strategy for Yerkes breeding program, we ultimately expect higher reproductive success as a result of more experienced breeder males.

Abstract # 21

AN ASSESSMENT OF PORCHES AS ENRICHMENT FOR SINGLY HOUSED CYNOMOLGUS MACAQUES (*MACACA FASCICULARIS*)

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Effective environmental enrichment encourages usage, promotes species-typical behaviors, and/or decreases abnormal behaviors. Porches are small cages that attach to the primary cage of an animal to provide additional space and a better view of the surroundings. This study aimed to assess porches as a form of enrichment and to identify characteristics of individuals most likely to use the porches. The behavior of 18 (9 male) singly housed cynomolgus macaques (*Macaca fascicularis*) was video-scored for three 15-minute observation intervals each week before, during, and after exposure to the porches. Changes in abnormal and tension-related behaviors (pacing, yawning, scratching) and species-typical behaviors were compared between the pre-porch, porch, and post-porch weeks. Novel object temperament tests were performed before and after the study. Subjects spent an average of 75% of time in the porch during observation periods. Temperament, sex, and age were not predictors of porch usage, but animals in upper cages spent more time in porches than animals in lower cages ($t(16)=2.462$, $p=0.026$). There were no changes in pacing, yawning, or scratching behaviors, but activity and consumption (eating/drinking) decreased during and after porch exposure (Activity $F(2)=6.839$, $p=0.003$; Consumption $F(2)=4.440$, $p=0.020$). The porches are beneficial in that they are used for extensive periods of time. However, there were no clear results on the reduction of abnormal behavior or the increase in species-typical behaviors. Supported by P51OD011133.

Abstract # 22

THE RESPONSE OF SANCTUARY CHIMPANZEE (*PAN TROGLODYTES*) GROUPS BEFORE, DURING AND AFTER THE DEATH OF A GROUPMATE.

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Understanding the role death plays in a chimpanzee colony may influence management. Studying death-related events could be beneficial, since chimpanzees that retire to Chimp Haven also die here. We hypothesized that chimpanzees would respond to a dead groupmates' body that died due to illness or an acute event. Euthanasia deaths were excluded as the body is removed from the group. We created a survey for caregivers present at the time of death or when the body was discovered. Ten surveys were completed for six different deaths from five separate groups. The groups cried/whimpered and/or displayed/hit at the body in 50% of the deaths. Vigilance, watching and remaining near the body, occurred in 67%. When a chimpanzee passes, staff must access the body for necropsy. This requires isolating the body from the chimpanzee's group. In 83% of attempts, group members would not leave the body immediately (< 1 min). Isolation of the body took over 30 minutes in two cases. We suspected that the rank of an individual may influence the group dynamic after the individual's death, and group cohesion, based on proximity calculations, might be affected. We have collected 90 hours of data via scan sampling on 33 subjects (10 males, 23 females) in four groups. We present preliminary data on this aspect of the study, with no deaths in the selected groups to date.

Abstract # 23

INCREASING CAPTIVE CHIMPANZEE (*PAN TROGLODYTES*) ENGAGEMENT WITH MULTI-STEP COGNITIVE ENRICHMENT

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Environmental enrichment enhances the psychological well-being of animals and is therefore a vital part of the husbandry of captive animals. Since chimpanzees are a cognitively complex species, they may especially benefit from enrichment programs that focus on cognitive engagement. We developed a multi-step enrichment plan for seven chimpanzees at Oakland Zoo. Our enrichment consisted of two devices presented to the chimpanzees sequentially and then combined the two devices to learn how increasing complexity affects chimpanzee behavior. We collected 142 hours of behavioral data using focal, scan and all-occurrences sampling from June-November 2016. We hypothesized that by providing the chimpanzees with multi-step enrichment there would be an increase in overall activity but a decrease in aberrant behaviors. As hypothesized the introduction of the enrichment devices resulted in an increase in activity level. After the introduction of the first device there was a 20% increase in activity compared to baseline. After the introduction of the second device, there was a 5% increase in activity compared to baseline. However, the enrichment plan did not decrease aberrant behaviors, as expected. This study provides a preliminary investigation into the use of multi-step enrichment devices and their effect on captive chimpanzee behavior.

Abstract # 24

INCREASES IN FEEDING AND DESTRUCTIBLE ENRICHMENT DISTRIBUTION IN CAGED RHESUS MACAQUES (*MACACA MULATTA*) PROVIDE SOME BEHAVIORAL BENEFITS

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It is important to evaluate the effectiveness of environmental enrichment in meeting behavioral goals (e.g., decreasing abnormal behavior) and in making the best use of limited facility resources (e.g., money, personnel time). One/zero behavioral data on 12 abnormal behaviors were collected on caged rhesus macaques (*Macaca mulatta*) thrice weekly during the six months before and after two facility-wide changes in enrichment distribution. Four behaviors with sufficient expression (stereotypic locomotion, self-directed stereotypies, eye-directed, and feces-related behaviors) were analyzed using Repeated Measures Wilcoxon Signed Rank Tests. Following a simultaneous fresh produce distribution increase from two/three times weekly to five times weekly, and destructible enrichment distribution to singly-housed monkeys from once to twice weekly, 74% of (N = 111) animals who displayed stereotypic locomotion at least once during the pre-change period showed a decrease in that behavior ($Z = -4.53$, $p < .001$). Following a later increase in foraging opportunities from four/five times weekly to seven times weekly, 65% of (N=184) animals showed a decrease in stereotypic locomotion ($Z = -3.88$, $p < .001$), 74% showed a decrease in other self-directed stereotypies ($N = 27$, $Z = -2.55$, $p = .011$), and 81% showed a decrease in fecal-related behaviors ($N = 47$, $Z = -3.27$, $p = .001$). Behavioral improvements indicate that more frequent provision of feeding and destructible enrichment can moderate certain types of abnormal behavior.

Abstract # 25

ENHANCED PHYSICAL ENVIRONMENTS IN SINGLE-HOUSED MACAQUES: A LONG-TERM USAGE PROFILE OF CAGE EXTENSIONS.

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Social housing is always preferred in the research environment; however, single housing is sometimes necessitated by scientific objectives or social incompatibility. In these cases, other environmental enhancements are developed to provide indirect social interactions. We developed a novel cage extension that replaces the front of a standard cage to allow animals an enhanced visual perspective into the housing room and to provide additional space. To assess the effectiveness of the extension, we measured the amount of time that monkeys spent in the cage extension relative to the rest of the cage. We measured usage for 1 month following deployment and returned 6 months later to evaluate sustained use. Usage was evaluated using 3 strategies: Daily AM/PM location scan samples by animal research technicians; leading-minute direct observation by behavioral staff, and remote video recording with no human present. We followed twelve animals with cage extensions. Over the first month animals spent over 80% of the observed time in the cage

extensions. At the 6-month follow-up the animals spent 70% of their time in the extension; however, only 5 of the original animals remained in the room. Our findings show that the animals spent a large proportion of the time sampled in the cage extension and that this was maintained over time, thus suggesting that the use of extensions serve to promote non-contact social interaction

Abstract # 26

PROVIDING FEEDING ENRICHMENT BY HAND MITIGATES ANXIETY AMONG LABORATORY-HOUSED RHESUS MACAQUES (*MACACA MULATTA*)

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Some husbandry procedures may be perceived as aversive by cage-housed rhesus macaques. We assessed whether providing feeding enrichment by hand as opposed to placing it on a caging surface decreases anxiety responses to daily husbandry activities. Eleven adult males and 53 adult females housed at the Tulane National Primate Research Center were randomly assigned to one of two groups: thirty-eight were provided the opportunity to take feeding enrichment from the experimenter's hand, and 26, designated as controls, retrieved food from a surface attached to their caging. All animals received this feeding enrichment three times weekly. Levels of anxiety-related behaviors during room sanitation were measured using focal one-zero sampling. Trials were conducted at baseline and monthly during the three months of treatment. Preliminary results of a mixed model ANOVA, controlling for sex, found significantly lower anxiety levels among the hand-fed group ($p=.007$), and a trend towards an interaction between time point and group ($p=.079$). These results were driven by a monthly trial before which the control group experienced a stressful husbandry event that does not occur daily. Such events did not result in increased anxiety in the treatment group. Hand feeding may be an effective tool to reduce anxiety during husbandry activities, potentially by improving animals' perception of caretakers and thereby providing a buffer against stressful events.

Abstract # 27

MARAUDING MONKEYS: PREVENTING TRASH-RAIDING BEHAVIOR BY FREE-RANGING WHITE-FACED CAPUCHIN MONKEYS (*CEBUS CAPUCINUS*)

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Nonhuman primates that raid trash may suffer nutritional imbalances and experience heightened levels of aggression. Trash-raiding wildlife causes annoyance and health concerns for humans. This project tested the effectiveness of trash huts covered with steel mesh and fitted with locking doors to prevent access by two troops of capuchin monkeys at the Refugio de Mixta de Vida Silvestre Curú. In March 2015, behavioral data were collected before and after the trash was enclosed. Scans were conducted at 5-minute intervals beginning when the monkeys arrived near the enclosures, tallying the behavior of each group member and the food items consumed: trash, provisioned foods, and natural foods. Camera traps were used to verify that the trash enclosures were consistently used and locked by humans. Follow-up data were collected in May 2016 and January 2017. The trash enclosures effectively prevented theft by the monkeys, however the steel corrodes and must be regularly maintained to prevent rust. The activity budgets of the monkeys were not altered by the introduction of the trash enclosures, however there was a significant difference (ANOVA $p= 0.0018$) in the types of food consumed the monkeys: when trash became inaccessible, both troops increased the time spent consuming (in)directly provisioned foods. Additional research will focus on use of more durable materials, elimination of trash-raiding by raccoons, and a program to reduce wildlife feeding by tourists.

Abstract # 28

UNEXPECTEDLY HIGH PRIMATE SPECIES RICHNESS IN IGAPO FOREST IN AMAZONIAN PERU

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Higher primate species richness in Amazonia has been hypothesized for unflooded (terra firme) forests than for várzea forests, seasonally flooded by nutrient-rich white-water rivers, and igapó forests, seasonally flooded by nutrient-poor black-water rivers. Ability to occupy igapo has been predicted to depend on primates' ability to migrate seasonally into terra firme habitat. We tested this proposed relationship in primate species richness among the three forest types with survey data collected at sites in the Área de Conservacion Regional Comunal Tamshiyacu Tahuayo (ACRCTT) in northeastern Peru in 2005 and 2015. We recorded 12 sympatric primate species in igapo forest compared with 9 primate species in terra firme and varzea. A 13th species, *Lagothrix poeppigii*, reported but not encountered during the survey, and a second *Callicebus* species may also occur in igapo at this location. Our observations suggest that, as predicted by other researchers, the unexpectedly high species richness in igapo at this site may be due to the ability of at least some primate species to migrate into terra firme habitat during periods of food (probably specifically fruit) scarcity. While this level of species richness equals levels previously reported for primates at terra firme sites elsewhere in Amazonia (in Brazil), the ACRCTT site may have the highest species richness yet recorded for igapo forest. This indicates that conservation efforts should be directed at igapo forest.

Abstract # 29

WHO OWNS PET LEMURS? CHARACTERISTICS OF PET LEMUR OWNERS IN MADAGASCAR AS IDENTIFIED THROUGH FACE-TO-FACE INTERVIEWS

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Madagascar is home to the highest number of threatened primate taxa in any one country. Lemurs are threatened by forest loss and hunting; the pet trade has been recognized as an additional threat. Although it is illegal to own lemurs, pet lemur ownership is widespread and affects over 30 species. The goal of this study was to gain an understanding of who owns pet lemurs to better inform conservation programming. Previous studies have reported that lemurs were kept as pets and for money-making or tourism purposes leading us to hypothesize that owners would be Malagasy rather than foreign, primarily adults (males and females equally) and wealthy. Data were collected through face-to-face interviews across Madagascar in July-August 2017. Of 596 households sampled, we interviewed 33 current or former lemur owners. As hypothesized, results found that 97% (n=33) of lemur owners were Malagasy. Contrary to our prediction, 67% of lemurs were owned by children and their families (22/33 interviewed) and, as expected, male (n=16) and female (n=13) heads-of-households were equally represented (binomial p=0.7111, alpha=0.05). No significant difference in wealth of owners was found (54% wealthy (15/28 interviewed), binomial p=0.4253, alpha=0.05). Lemurs are owned for a variety of reasons including as pets (i.e. companionship) and for monkey-making. An understanding of who the owners of pet lemurs are will be helpful in determining which conservation strategies should be implemented.

Abstract # 30

POPULATION ASSESSMENT OF PRIMATES IN RELATION TO HUNTING PRESSURE IN THE GRAN CALDERA SOUTHERN HIGHLANDS SCIENTIFIC RESERVE, BIOKO ISLAND

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We surveyed the southern portion of the Gran Caldera Southern Highlands Scientific Reserve in order to estimate the density of 4 primates, the Bioko drill, (*Mandillus leucophaeus poensis*), Bioko crowned guenon (*Cercopithecus pogonias pogonias*), Bioko putty-nose monkey (*Cercopithecus nictitans martini*) and Bioko red-eared guenon (*Cercopithecus erythrotis camerunensis*), and assess habitat use in relation to hunting activity near the only existing road in the reserve. After its construction in 2014, this paved road bisects the scientific reserve and connects the second largest town on the island with the southern beaches, providing access from both the road and the beach. We set up 9 line transects at 2 survey sites, one site progressing from the road into the forest and the second from the beach into the forest, representing areas with different levels of hunting pressure. We estimated primate density by using distance sampling method as described in Buckland et al. 2010. Each transect was 2 km long and was walked > 8 times (transects walked= 120; transect effort= 236 km) from November 2016 to February 2017. We used general quadrat habitat assessment concurrently along each transect to assess primate density in relation to habitat use. Our data indicates that primate density is negatively correlated with hunting pressure. This is one of the first studies to investigate the impact of this road on primate populations on Bioko.

Abstract # 31

FACTORS AFFECTING THE CROP-RAIDING BEHAVIOR OF AN EASTERN CHIMPANZEE POPULATION IN GISHWATI FOREST, RWANDA

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Previous research has suggested that forest fragmentation and anthropogenic activities increase conflict between humans and chimpanzees. Gishwati forest, Rwanda is home to an eastern chimpanzee (*Pan troglodytes schweinfurthii*) population of ~30 individuals that raid nearby farms for maize. We investigated crop-raiding in this population through observations of feeding remains in maize fields to determine the environmental predictors (size of maize field, distance to forest) of this behavior. A total of 10 crop-raiding events were observed between November 2016 and February 2017. The events occurred in only two (10%) of the 21 maize fields surrounding Gishwati. We found that neither the size of the maize field nor the distance of the maize field to the forest predicted the occurrence of crop-raiding ($F_{2,18} = 0.04$, $p = 0.96$). Additional factors that may influence crop-raiding include topography, the distance of a maize field to human settlements, and a chimpanzee's prior experience raiding a field. Results from this study will help to inform ongoing efforts to mitigate crop-raiding by primates.

Abstract # 32

PRELIMINARY OBSERVATIONS OF A PREVIOUSLY UNREPORTED POPULATION OF RHESUS MACAQUES (*MACACA MULATTA*) IN CHIANG RAI PROVINCE, THAILAND

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Assessing the distribution and status of nonhuman primate populations are essential for effective conservation and management of the species. In Thailand, pioneering work by Aggimarangsee (1992) and Malaivijitnond & colleagues (2002, 2005) has provided important data on macaque distribution throughout the country. Here we add to the growing database with a summary of a previously unreported population of rhesus macaques located at Wat Phrabuddhabat Pa Reau in Chiang Rai Province. This work is part of an on-going study addressing human-primate conflict and coexistence in Thailand. The Wat covers an area of about 53ha and consists of forest and pond surrounded by agricultural fields. The macaques receive some provisioning by Wat staff and local people. We conducted observations of the macaques and interviews of the monks, Wat staff, and local people during 20-21Nov2015 and 22-23Jul2016. Those interviewed (n=12)

reported population sizes between 100-2000 monkeys and 1-4 groups. All individuals reported crop raiding. Based on our observations, we identified at least two groups with group sizes of 55 and 44 monkeys. We also observed active crop raiding. All those interviewed expressed growing concern over an “increasing” monkey population and need for more effective population management. We plan to conduct a more intensive survey of this population, including health assessment and genetic analysis, later this year. Assistance/Support: NRCT; MSU Development Fund; OneEarthInstitute; ORIP-NIH Grant No. P51OD010425 to WaNPRC.

Abstract # 33

POPULATION STATUS OF THE LONG-TAILED MACAQUES (*MACACA FASCICULARIS*) AT KOSUMPEE FOREST PARK, MAHA SARAKHAM, THAILAND

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In many parts of the world, habitat loss and urbanization are resulting in increased interaction and conflict between human and nonhuman primates. As part of a larger study addressing human-primate conflict and coexistence in Thailand, we conducted an assessment of the long-tailed macaques at Kosumpee Forest Park (KFP) in Northeast Thailand, a site of increasing human-primate conflict. Although there have been previous studies at KFP, detailed assessment of the macaque population has been limited. Here we report on the population status of the macaques at KFP. A population survey and behavioral observations were conducted over a three-month period (18Sept–23Dec 2016). Traditional methods to estimate population size were not possible given the high population density, diffuse group cohesion, and extensive home range overlap. We created a detailed photographic directory of individuals to assist with group member identification and confirmation of groups. Five groups were confirmed. Average group sizes ranged from 66 to 217 individuals. Total population size was estimated at 734 monkeys. Given the size of KFP (0.2km2), this translates to a population density of 3,670 individuals/km2. Local people complained of the increasing number of monkeys and conflict. A comprehensive research approach is essential to identify the most appropriate management strategies across human, primate, and environmental domains for a sustainable, healthy coexistence. Assistance & Support: NRCT; MSU Development Fund; OneEarthInstitute; ORIP-NIH Grant No. P51OD010425 to WaNPRC.

Abstract # 34

STILLBIRTH RATES ACROSS APE SPECIES IN ACCREDITED AMERICAN ZOOS

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Stillbirths, or births of infants that died in the womb, represent a failure of the maternal-fetal-placental unit to maintain normalcy. What is known about nonhuman primate (NHP) stillbirth patterns is primarily descriptive and often based on studies of macaques. Less is known about other NHP species and more rare still are comparative studies that examine possible factors that influence stillbirth rates. To examine the relationship between demography and stillbirths in great apes, we used historical birth data of American accredited zoo-housed chimpanzee, Pan troglodytes (n=151), gorilla, *Gorilla gorilla* (n=103), and orangutan, *Pongo* (n=87), mothers from 1990 to 2016. The average number of births for each of the 341 mothers was 2, resulting in a total of 641 successful births and 91 stillbirths (12%). Stillbirths represented 13% of chimpanzee births, 16% of gorilla births, and 7% of orangutan births. We tested for possible relationships between stillbirth likelihood and mother origin (wild- versus captive-born), age, and species. Mixed effects models found that species, age, and origin did not significantly influence stillbirth likelihood ($p > 0.05$). While these results are likely influenced by both biological and management-related factors (e.g. selective captive breeding), they may be useful to population managers in evaluating pregnancy risks for great apes. Captive settings and archival studbook data such as these may provide a unique opportunity to further explore this topic.

Abstract # 35

DETERMINANTS OF THE ADULT MICROBIOME: KINSHIP, DISPERSAL, AND SOCIAL RELATIONSHIPS

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Primates who disperse from their natal group may shape their adult stable gut microbiome through physical contact, and shared environments with their new group members. However, it is possible that individuals retain the dominant microbiome composition that they developed as an infant in their natal group even after joining their new group due to a combination of genetics and exposure to their natal group environment. We studied *Eulemur rubriventer* (red-bellied lemur) who live in family groups. We tested whether indivuiduals now living in different social groups as adults overlap in microbe composition, and if areas of overlap are distinct compared with unrelated individuals. We also tested whether the gut microbiomes of co-residents (dispersed adult group-mates) would be more similar than that of individuals living in different groups. Using census and genetic data, we determined the social group membership and relatedness of 15 individuals in Ranomafana National Park, Madagascar. Quantitative real-time PCR and Microbial 16S ribosomal RNA gene sequencing indicated that *E. rubriventer* kinship accounted for just 2.4% of variability in gut microbiome diversity. Our findings indicate that host adult social group explained 25% of the variation in composition of *E. rubriventer* microbiomes. Additional research incorporating an increased sample size to include additional kin dyads is necessary to fully understand the influence of genetic kinship and early life colonization on the GI microbiome.

Abstract # 36

PHYLOGENY VERSUS NICHE DIFFERENTIATION IN THE DIETS OF MALAGASY PRIMATES

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The influence of phylogeny on diet in primate communities remains an understudied topic in primate ecology and evolution. Previous studies have focused on anthropoid communities and, in general, determined that dietary similarity is correlated with phylogeny such that more closely related species exhibit greater dietary overlap. The role of phylogeny in driving dietary similarity in Malagasy strepsirrhines, however, remains unclear. This study tests the hypothesis that, like haplorrhines, Malagasy primates will show a strong correlation between phylogeny (as measured by divergence distance) and dietary similarity. Phylogenetic and feeding data were obtained from the existing literature. Using Mantel tests, correlations between divergence distance and percent similarity in diet were shown for lemur species with sufficient data in each of four communities: Ranomafana National Park (n=9), Berenty Private Reserve (n=4), Kirindy Forest (n=5), and Beza Mahafaly Special Reserve (n=3). Results were mixed between the communities, showing both a strong negative correlation between divergence distance and overall dietary similarity for Ranomafana and no correlations for the other sites, using 0.05 as threshold of significance. Strepsirrhines seem to differ from haplorrhines in whether phylogeny or niche differentiation shows a stronger influence over diet; however, this may depend on the region in Madagascar. The mixed results seen here raise questions about factors influencing community composition in Madagascar.

Abstract # 37

FEEDING PREFERENCES OF MANTLED HOWLER MONKEYS (*ALOUATTA PALLIATA*) BY TREE DIAMETER IN A FRAGMENTED FOREST OF COSTA RICA

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Feeding behaviors of the mantled howler monkey, *Alouatta palliata*, are widely documented in terms of their activity budgets and diet composition, but investigations of preferences based on tree maturity are lacking. This study focused on the relationship between feeding behavior and tree diameter at breast height (DBH) using focal animal point sampling techniques on multiple*A. palliata* groups in a forest fragment at the La Suerte Biological Reserve in Costa Rica in January 2017. I predicted that monkeys would most often feed in mature trees with a DBH of ≥3m. During 16 hours of data collection, animals were followed for 30 minutes with behaviors sampled at 30 second intervals. Trees were identified as feeding trees if focal animals fed in the same tree for ≥2 mins during sampling. A total of 32 individuals were sampled and 16 feeding trees were measured. 92.7% of observed feeding behaviors were performed in trees with DBH <3m, contradicting my prediction that *A. palliata* prefer to feed in large trees. The median tree diameter for individuals exhibiting feeding behavior was 1.67 m. Broader knowledge of *A. palliata* feeding preferences by tree maturity and other factors may inform habitat preservation and reforestation strategies. If *A. palliata* consistently feed in smaller, less mature trees, then efforts in habitat regrowth may be effective for *A. palliata* in relatively short time periods.

Abstract # 38

URINARY INDICES OF HEALTH IN ADULT MALE BLACK HOWLERS (*ALOUATTA PIGRA*) IN BALANCÁN, MÉXICO

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Based on urine samples, females with infants at Ranchería Josefa Ortiz de Dominguez had better health than females without infants. As health of males might also be relevant, male health was evaluated based on group structure (one-male vs. multi-male), habitat (playón vs. rainforest), and group immature-to-female ratios (< 1.0 vs. > 1.0). Urine samples obtained February-April 2012 were tested with commercially-available reagent strips for 10 parameters. Overall, differences in health-related indices were few (two-tailed z-tests for differences between proportions). Rainforest males in one-male groups (17 samples) had significantly more samples with above-trace amounts of bilirubin and leukocytes (both $p < .003$) than males in multi-male groups (44 samples), suggestive of liver or kidney problems, and these differences held when habitats were combined (9 one-male groups, 21 samples; 14 multi-male groups, 89 samples); there were too few samples from one-male playón groups to assess differences within that habitat. Rainforest males, in general, had significantly more samples (of 61) containing ketone than playón males (36 samples; $p < .008$), suggestive of nutritional stress, perhaps related to higher social density and competition. There were no differences in health indices between males from reproductively successful groups (high ratios) compared to low ratio groups (14 and 6 groups, respectively). While males in one-male groups might have greater risk for some health problems, overall male health did not vary dramatically.

Abstract # 39

SEX DIFFERENCE IN THE IMPACT OF DOMINANCE CERTAINTY AND RANK ON HAIR CORTISOL CONCENTRATIONS IN RHESUS MONKEYS (*MACACA MULATTA*)

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Both rank and dominance certainty have been associated with biomarkers of health. Recent research suggests the effects of rank and dominance certainty may be sex dependent, potentially due to differences in how rank is attained. To explore the influence of sex in dominance relationships we used the Perc package in R to calculate dyadic dominance probabilities for all animals which were used to calculate (a) rank order, (b) average dominance certainty with females, and (c) average dominance certainty with males to explore their influence on hair cortisol concentrations (HCC). Event recording of aggressive interactions was done over 6 weeks on three large outdoor social groups of rhesus macaques (N=252) at the California National Primate Research Center, and hair was collected during the 5th week of observation. A best fit generalized linear model was selected based on AIC. Results indicate that low-ranked animals had higher HCC than high-ranked animals (alpha=0.05). Effects for dominance certainty were more complicated. Animals whose relationships with males in the group were highly certain had higher HCC. In contrast, animals whose relationships with females were ambiguous showed higher HCC, but only for males. There was no impact of dominance certainty on HCC among females. These results support the idea that dominance certainty impacts physiology, but highlights the fact that effects of dominance certainty may differ between males and females in important ways.

Abstract # 40

EFFECTS OF EARLY LIFE EXPERIENCES ON AGGRESSION, AFFILIATION, OXYTOCIN AND ARGININE-VASOPRESSIN IN CAPTIVE *CALLICEBUS CUPREUS*

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Coordinated activation of oxytocin (OT) and vasopressin (AVP), in conjunction with partner-directed behaviors, help maintain monogamous bonds. Negative early-life experiences (e.g. loss of parent, trauma) can lead to increased aggression and lower baseline AVP concentrations. We conducted a mirror study using 20 coppery titi monkey (*Callicebus cupreus*) pairs to identify the effects of experience on AVP, OT, and responses to a perceived intruder in a monogamous New World monkey. A mirror was moved in front of the subject's homecage for 5 minutes, showing either the back of the mirror (control), or the reflective front of the mirror (experimental). A total of 2 exposures (1 experimental, 1 control) were completed. Behaviors were scored using an established ethogram. We conducted femoral blood draws after both conditions to quantify plasma OT and AVP using enzyme immunoassay validated for titi monkeys. We used generalized linear mixed model analysis of variance to predict changes in AVP and OT levels from baseline as a function of changes in recorded behaviors, early-life stressors, and their interactions. We expect to observe positive relations between early adversity and changes in aggression. We also expect a to observe a greater increase in OT and AVP levels from baseline in males that experienced early-life adversity. Results from this study may help elucidate potential causes of and neurobiological mechanisms underlying aggression.

Abstract # 41

ESTIMATING APPARENT DRY MATTER DIGESTIBILITY USING DIETARY MANGANESE THE COMMON MARMOSET (*CALLITHRIX JACCHUS*)

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Captive common marmosets display a wide range of digestive abilities linked to intestinal inflammation which can lead to chronic diarrhea, weight loss, vitamin D deficiency, and eventually marmoset wasting syndrome and/or metabolic bone disease. Animals that appear healthy can have digestive efficiency 5 – 10 percentage points lower than completely healthy marmosets. Detecting animals with subacute digestive difficulties is important for overall health and because variation in digestive abilities can introduce unaccounted for variation in research studies. We tested a method of estimating apparent dry matter

digestibility (ADMD) using naturally occurring manganese in the diet. Animals (N = 40) were individually housed and all food given was weighed and samples taken to determine the dry matter content. All uneaten food and feces was collected every day for two four-day digestion trials for each subject to calculate dry matter intake (DMI) and fecal output. ADMD was calculated by 1 - dry weight of feces/DMI. Manganese concentration ([Mn]) of food and feces was assayed using atomic absorption spectrophotometry, and ADMD estimated by 1 – [Mn of food]/[Mn of feces]. Estimates of ADMD ranged from below 65% up to almost 85%. Estimates of ADMD by the total collection method were higher than by Mn concentration, but the two estimates were strongly correlated ($r=0.901$, $p<0.001$). Mn concentration in feces can be used to estimate the digestive ability of marmosets.

Abstract # 42

EVOLUTION OF *CYP2C* GENE CLUSTER AMONG THE HOMINOIDEA

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Cytochrome P450 enzymes are encoded by a diverse superfamily of genes, some of which detoxify so-called xenobiotic compounds from an animal's diet (e.g., plant defensive compounds). Genes from this functional category have been shown to be prone to duplication, pseudogenization and/or deletion. Our study examines the *CYP2C* subfamily of genes, which are all present in a similar syntenic pattern among well-annotated anthropoid genomes. We aligned genomic DNA and mRNA sequences for all syntenic protein-coding *CYP2C* genes available for *Homo sapiens*, *Pan troglodytes*, *P. paniscus*, *Gorilla gorilla*, *Pongo abelii*, *Nomascus leucogenys*, and *Macaca mulatta* in the NCBI Gene and Ensembl 87 databases. An intron shared by 26 out of 30 protein-coding *CYP2C* genes (range: 3-9 genes per species) was analyzed by maximum likelihood (ML); this analysis revealed close phylogenetic cohesion of these genes within four gene-clades. Additional ML analyses of the translated protein-coding sequences (28 of 30 genes) implied putative cohesion of function among these genes as well. Overall, our data indicate an instance of retained duplication of the *CYP2C9* gene in the basal hominoid lineage, independent deletion of the *CYP2C18* gene in the panin lineage and that of *Nomascus leucogenys*. Because these genes encode enzymes that interact with exogenous substrates present in the diet, our results provide insights for further inferences of the early ecology or physiology of the hominoid radiation.

Abstract # 43

USING MOLECULAR TECHNIQUES TO DETERMINE PROVENANCE OF ILLEGAL RING-TAILED LEMUR (*LEMUR CATTA*) PETS TO INFORM CONSERVATION ACTIONS

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The ring-tailed lemur (*Lemur catta*) was once widespread across southern Madagascar. However, anthropogenic activities, such as habitat loss, hunting for bushmeat, and live capture for the illegal pet trade have caused ring-tailed lemur populations to plummet in the past decade. Here, we compare genotypes of illegal wild-caught pet and confiscated ex-pet ring-tailed lemurs to those from wild populations to determine their source localities. To date, fecal samples have been collected from 26 wild-caught pet *L. catta* individuals. DNA was extracted and amplified at eight polymorphic loci following Parga et al. (2012, 2015). To determine the geographic origin of captive and confiscated lemurs, their genotypes were matched to a geographically-referenced allele frequency database generated from a reference library of 68 adults sampled from five wild *L. catta* populations (Anja, Bezà Mahafaly, Sakaviro, Tsinjoriake, Tsimanampesotse).

Ultimately, results of this study can be used to help determine geographic “hot spots” of wildlife trafficking for which targeted conservation initiatives – including heightened security and increased conservation outreach – can be developed. This is a pilot study and additional sampling of both captive and wild populations of *L. catta* will be needed to accurately pinpoint these trafficking hot spots.

Abstract # 44

NEURAL AND GENETIC MECHANISMS UNDERLYING TOOL USE PERFORMANCE VARIATION IN CHIMPANZEES (*PAN TROGLODYTES*)

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Manufacturing and employing effective tools involves complex motor and cognitive functions that likely evolved in humans along with increased brain size and specialization. Aside from humans, chimpanzees exhibit unrivaled complexity and diversity in tool use form and function. Studies show notable variety within and across wild chimpanzee communities, and captive studies show tool use performance to be highly heritable. Here, we investigated the neural and genetic bases for tool use performance. We obtained MRI scans and tested 201 chimpanzees on a probing task to determine tool use skill. We used source-based morphometry (SBM) to identify structural co-variation of gray matter volume and determine their potential associations with tool use skill. Independent component analysis identified 19 independent gray matter components. After controlling for age, sex and rearing history, two of the SBM components correlated with tool use performance, namely the primary visual cortex (partial r=.209, p=.002) and inferior parietal cortex (partial r=.218, p=.002). Using quantitative genetics, we found significant genetic correlations between tool use performance and the visual cortex (rhog=.756, p<.05) and inferior parietal lobe (rhog=.920, p<.04). Our results indicate common genetic mechanisms involved in tool use and gray matter co-variation, particularly in the visual and inferior parietal cortex. These, as yet unknown genes, may have been selected for in primate evolution and account for the expansion in tool making and use skills observed in humans.

Abstract # 45

VARIATION IN THE M-OPIOID-RECEPTOR GENE MODULATES MATERNAL BEHAVIOR IN OUTDOOR-HOUSED *MACACA MULATTA*

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A C-to-G single nucleotide change in the μ-opioid-receptor gene (OPRM1-C77G) modulates mother-infant relationships in rhesus macaques (*Macaca mulatta*). Mothers with the CG genotype restrain their infants more often, preventing play and exploration, potentially indicating lower quality bonding. Infant genotype affects infant temperament, with the CG genotype interacting with sex. CG genotype males exhibit increased rates freezing, and females show decreased rates of freezing, compared to infants with the CC genotype. The present study investigates the effect of OPRM1 genotype on the mother’s behavior with her infant. For the first 24 weeks of infant life, weekly behavioral data were collected from 42 mother-infant pairs. Each mother was genotyped for variation in the OPRM1 gene. Mixed design, repeated-measure ANOVAs, with maternal genotype and infant sex as between-subjects factors and week of life as the within-group factor, showed that maternal restraint was modulated by genotype and infant sex (F=2.658; p<.0001), with CC mothers restraining female infants more than CG mothers. Social contact between mother and infant was significant, with CG mothers exhibiting more contact in later months (F=1.75; p=.015). Maternal approach was significant

(F=1.585; p=.039), with CG genotype mothers approaching female infants more. Results indicate that OPRM1 genetic differences modulate quality of maternal care. Mothers homozygous for the ancestral C allele exhibit higher quality parenting behaviors than do mothers with a copy of the G allele.

Abstract # 46

RAPID, INEXPENSIVE GENOTYPING AND BARCODING OF PRIMATES: MULTIPLE APPLICATIONS FOR HIGH-RESOLUTION MELT ANALYSIS IN PRIMATOLOGY

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Research in molecular ecology and conservation genetics often entails genotyping single nucleotide variants (SNVs). High-Resolution Melt Analysis (HRMA) is a simple and economical method for detecting DNA variants by characterizing the sequence-specific melting behavior of short PCR products. To-date HRMA use has largely focused on medical screenings, but this method has numerous potential applications in primatological genetics. We developed and tested (via Sanger sequencing) several protocols demonstrating the convenience and flexibility of HRMA in primatology. First, we assessed the ability of HRMA to discern color vision status in lemurs (n=87 of 9 species) via X-linked opsin genotypes. Differences in melting curves (temperature and shape) allowed us to reliably identify trichromatic and dichromatic individuals with high accuracy. Second, we targeted SNVs commonly associated with autism and/or behavioral tendencies (oxytocin receptor gene, OXTR) in humans (n=60) and were able to accurately genotype individuals based on melting curves. Third, we used HRMA for rapid species identification using a segment of cytochrome c oxidase 1 (*COX1*). Results indicate that sympatric primate species, including some lemurs and apes, can be accurately identified using HRMA. Finally, we have used HRMA for health screenings of interleukin-4 (*IL4*) SNVs that are associated with nematode infection loads in *Eulemur rufifrons*. Our results demonstrate that HRMA is a multipurpose and robust method for genotyping simple functional and neutral genetic variants.

Abstract # 47

SEROTONIN RECEPTOR 1A (*5-HTR1A*) VARIATION IS ASSOCIATED WITH ANXIETY AND AGGRESSION IN CAPTIVE CHIMPANZEES

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The purpose of this study was to investigate proximate genetic mechanisms behind personality in chimpanzees (*Pan troglodytes*). Personality was measured using two approaches: a personality psychology approach (rating: MD Anderson N=137 chimpanzees, Yerkes N=77 chimpanzees) and a behavioral ecology approach (coding: NIB Center; N=64 chimpanzees). Next, we investigated the association between variation in the gene coding for 5-hydroxytryptamine receptor 1A (*5-HTR1A*) and personality. *5-HTR1A* is a 5-HT receptor subtype that binds to serotonin, a neurotransmitter important for regulating anxiety, impulsivity and aggression, as documented in a variety of mammals. In chimpanzees, a C/A SNP is present in exon 1, changing a proline to a glutamine in the amino acid sequence. Genotyping was performed using high-resolution melt analysis and genotype frequencies were in Hardy Weinberg equilibrium (X2=0.19, df=1, p=0.656) with the derived allele present at higher frequency (0.67). Our results show a significant association between genotype and rated item "anxious", with heterozygous chimpanzees being rated higher than chimpanzees with the ancestral genotype (CC) (F(1,2)=4.06, p=0.019). A marginally significant genotype-testosterone interaction effect was found for the coded factor "Aggressiveness" (F(10,2)=4.405, p=0.051), with males homozygous for the derived allele scoring higher and having higher mean testosterone scores than males homozygous for the ancestral genotype. These results are the first evidence showing that the *5-HTR1A* gene plays a potential role in regulating behavior in chimpanzees.

Abstract # 48

VARIATION IN MATERNAL AND NON-MATERNAL INFANT HANDLING DURATIONS IN AN AFRICAN COLOBINE (*COLOBUS VELLEROSUS*)

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Infant handling is predominantly regulated by the level of maternal tolerance for others touching the infant. Thus, infant handling represents a source of maternal flexibility that may vary in response to selective pressures. We compared handling time from mothers and non-mothers, and examined which external factors may be impacting 'total' (maternal/non-maternal combined) handling time. From June-Oct 2016 we collected 10-minute continuous focal observations (n=1,469) on infants (n=16) from four ursine colobus (*Colobus vellerosus*) groups (1 unimale, 3 multimale) at the Boabeng-Fiema Monkey Sanctuary, Ghana. Infants ranged in age from newborn to 78 weeks. We knew all individual infant and handler identities. We observed 1,458 bouts of handling (1,169 maternal, 289 non-maternal). The mean 'total' observed handling duration per infant was 21,874.11s (range = 4562.105s-43267.840s). We investigated the effect of infant-handler dyad type (maternal/non-maternal), group type (uni-/multimale), maternal parity (prima-/multiparous) and infant sex using Linear Mixed-Effects Models in R with the nlme package and lme function. We included individual identity as a random effect. Mothers handled infants for more time than all non-mother individuals combined (beta=365.01, SE= 16.03, DF=122, p=0.00). 'Total' handling time did not differ significantly based on group type (beta=-26.25, SE= 45.33, DF=122, p=0.56), maternal parity (beta=41.49, SE=46.40, DF=122, p=0.37), or infant sex (beta=28.63, SE=35.73, DF=122, p=0.42). These results suggest maternal handling may buffer the amount of variation in 'total' handling time.

Abstract # 49

SIGNIFICANT DIFFERENCES IN INFANT CARE IN SAN MARTIN TITI MONKEYS (*PLECTUROCEBUS OENANTHE*) IN PERU

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Parental investment is high in primates, yet it is unclear what effects environmental factors have on this investment. This study examined the impact of food availability, group identity, and infant age on the frequency of parental care, male care, alloparental care, and overall infant care in two habituated groups of *Plecturocebus oenanthe*. Research was conducted for 10 months from 2015 to 2016 and a total of 9,263 infant observations were collected. Leaf availability was calculated as the monthly average of foliage percentage. Monthly fruit and flower availability were estimated from September to December in 2016 by dividing the number of fruit and flower-bearing trees by the total number of trees monitored. Data were analyzed using generalized linear mixed models in SAS 9.4. Alloparental care was significantly higher, and all other forms of care were significantly lower in Group 1 than in Group 2 in 2015 ($p<0.01$). The interaction between group identity and infant age significantly impacted parental care and overall infant care ($p<0.05$) in 2016. Food availability was significantly associated with male care ($p<0.01$). It is unknown why there were significant differences in infant care between groups in 2015, though infant rejection was observed more often in Group 1. Results from 2016 suggest that food availability impacted male care, however given the small sample size caution should be used when interpreting results more broadly.

Abstract # 50

WHAT PRIMATES FORGET REVEALS HOW THEY REMEMBER: SEQUENCE-LEARNING ERRORS MADE BY APES (*GORILLA GORILLA GORILLA*) AND MONKEYS (*MACACA FUSCATA*) SUPPORT THE ORDINAL MODEL OF SERIAL LEARNING

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The ability of primates to remember sequences is well documented. Less understood is what sequence-learning errors reveal about primate memory. Five gorillas and seven macaques, socially housed at Lincoln Park Zoo (Chicago, IL), were tested on a touchscreen serial-learning task. Subjects had to select symbols in a pre-determined order. After learning a two-item list (A-B), a third symbol (C) was added. When presented with the 3-item list, 31.1% of the subjects' first 30 trials were correct on average. Rate of successfully sequencing the symbols varied by subject ($P<0.001$) but not by species or trial (both $P>0.05$). Success rate (mean=58.9%) was positively associated with selecting symbol A as the first list-item ($P<0.001$). However, in these trials subjects only subsequently chose symbol B, rather than C, at chance (mean=53.1%), with no variation across subjects ($P>0.05$). This suggests a failure to encode the last item (B) in the previously-learned sequence (A-B). The responses of one gorilla, who learned 4-, 5-, 6-, and 7-item lists, revealed the same encoding error: when he correctly sequenced n-2 items, he chose penultimate symbol at chance (mean=44.5%), with no effect of sequence length ($P>0.05$). The primates' failure to encode the last item in a sequence, as revealed when a novel symbol was added in the ultimate position, supports the ordinal model of serial learning, such that encoding strength decreases by list-item position.

Abstract # 51

TUFTED CAPUCHIN (*CEBUS [SAPAJUS] APELLA*) RISK PREFERENCES

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Although it is well known that risk impacts decision-making, less work has looked at the role of context. For example, people gamble more in social situations, but do their preferences change when another individual may win the outcome that they lose? We hypothesized that individuals would prefer options with relatively equal payoffs when another individual received the 'lost' option. Thirteen capuchin monkeys learned the value of 6 equally sized but distinctly colored and patterned tokens, each representing a different reward size (1-6 cheerios, respectively). Subjects were then trained to select a high value token pair over a low value token pair (e.g. 5/6 over 1/2). In tests, subjects chose between pairs of tokens were placed on either side of a lazy Susan. The experimenter spun the lazy Susan, stopping with a predetermined token in front of the subject, who exchanged it for its associated reward. In the solo condition, subjects were alone and the other token was discarded; in the paired condition, subjects had a partner who received the second token (and associated reward). Subjects completed 5 sessions of 16 trials of risk neutral, risky, and prospect and inequity comparisons. Preliminary results indicate an aversion to risky options in prospect conditions (probit regressions: B=-1.08, z=-11.49; B=-1.19, z=-30.72; B=-1.01, z=-4.88; ps<.001), and that the presence of a partner may also influence the monkeys' preferences.

Abstract # 52

TRADING UP: CHIMPANZEES (*PAN TROGLODYTES*) SHOW SELF-CONTROL THROUGH THEIR EXCHANGE BEHAVIOR

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Self-control - the ability to forego an immediately available reward in lieu of an objectively more desirable reward after a time delay or through greater effort - has been assessed in nonhuman animals with a variety of tests, including exchange tasks. Exchange tasks provide an intuitive and spontaneous measure of self-control as they require little to no training as the animals are faced with the option of eating a currently-possessed food item or inhibiting this response to exchange the food for a better reward. The current study utilized item exchange as the active behavioral response to measure self-control among three chimpanzees (*Pan troglodytes*). Chimpanzees were offered opportunities to "trade up" by exchanging a currently possessed food

item for an often better reward, sometimes needing to make several exchanges before receiving the best reward. To assess the factors that impact performance in obtaining the highest-valued item, we manipulated reward type, size, visibility, delay to exchange, and location of the highest-valued reward in the sequence of exchangeable items. Despite some individual differences across experiments, in most cases, the chimpanzees showed self-control by trading until successfully obtaining the highest-valued item. These results support the concept that self-control in chimpanzees is robust, even when sustained delay of gratification and perhaps anticipation of future rewards is required.

Abstract # 53

THE FORGOTTEN APE: EXPLORING THE COGNITIVE ABILITIES OF *SYMPHALANGUS SYNDACTYLUS*.

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Cognitive testing of zoologically-housed siamangs (*Symphalangus syndactylus*; Hylobatidae) is being conducted using touch-screen hardware and software (CANTAB, Lafayette Instruments) designed to evaluate a range of cognitive capabilities. Extensive testing has been completed with one subject; other subjects currently are being evaluated. After training on the use of the touch-screen, 418 cognitive trials were completed with the first subject (nulliparous female, age 7) over 8 testing sessions (~50 trials/session). Three cognitive tests were used: Delayed Match-to-Sample (DM), Conditional Visual Discrimination (CVD), and Concurrent Discrimination (CD). Cumulative performance on DM (mean = 45% correct, n = 2 sessions) and CVD (47%, n = 2 sessions) was lower than that of CD (82%, n = 4 sessions; ANOVA: $F(2,5) = 23.67$, $p < 0.003$). The addition of distractors to CD trials caused a 1-session drop in performance, which was recovered in the subsequent session. Siamangs are highly competent using touch-screens, with response latencies during CVD (3.24 sec) consistently longer than those of DM (1.55 sec) and CD (1.69 sec; ANOVA: $F(2,5) = 12.39$, $p = 0.012$). These data suggest that hylobatids are as cognitively capable as rhesus macaques (*Macaca mulatta*) and may possess cognitive abilities approaching some great ape species. This study provides pioneering data demonstrating the poorly-studied cognitive abilities of hylobatids, and also provides critical comparative information for evolutionary evaluation of the primate brain.

Abstract # 54

RESPONSES TO THE ASSURANCE GAME IN SQUIRREL MONKEYS (*SAIMIRI BOLIVIENSIS*)

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The evolutionary roots of economic behavior have received increasing attention in recent years. The use of games developed in experimental economics has allowed multiple primate species' economic decision making capabilities to be compared by utilizing similar methodologies. In this study we presented a version of the Assurance Game, previously employed with other nonhuman primates, to investigate whether captive squirrel monkeys coordinate responses to find a payoff-dominant Nash equilibrium. Four squirrel monkey pairs (3 female-female, one male-male) were given the option to select a white token, always yielding a single reward, or a black token, yielding four rewards only if both monkeys selected it on any given trial (200 trials conducted per pair, up to 20 trials per session). Overall, squirrel monkeys pairs did not converge on the payoff-dominant strategy in later trials (final 60 trials: x2: $ps>0.05$; black-black responses ranged from 20-53%). However, one female pair developed a 'color matching strategy', selecting the same colored tokens in 73% of their final 60 trials ($x2 = 13.07$, $df = 1$, $p<0.001$). These two females, along with one other female, developed individual preferences for the black token (binomial tests: $ps<0.05$). We are running additional sessions to determine whether these patterns remain consistent. Overall, squirrel monkeys showed very little behavioral coordination, although one pair developed a matching strategy that was previously documented in chimpanzees.

Abstract # 55

LOW INHERENT SENSITIVITY TO THE INTOXICATING EFFECTS OF ETHANOL IN LABORATORY-HOUSED RHESUS MONKEYS (*MACACA MULATTA*) WITH LOW CSF CONCENTRATIONS OF THE SEROTONIN METABOLITE 5-HYDROXYINDOLEACETIC ACID

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A reduced response to the intoxicating effects of alcohol, and low central nervous system (CNS) serotonin are known predictors for alcohol use disorders. These studies, performed on young adults with a previous drinking history, left open the possibility that individuals who drink more often develop tolerance rather than possess initial sensitivity to alcohol, leading to high intake. We utilized a nonhuman primate model to investigate the relationship between sensitivity to alcohol and CNS serotonin activity. Cerebrospinal fluid (CSF) samples were obtained from 82 alcohol-naïve rhesus monkeys, and were assayed for concentrations of the serotonin metabolite 5-hydroxyindoleacetic acid (5-HIAA). One month later, subjects were administered an IV alcohol bolus, placed into a suspended Plexiglass chamber, and time to escape was recorded. Subjects were observed for the next 35 minutes and rated for level of intoxication. Escape latency was positively correlated with intoxication ratings ($r=.69$, $p<.0001$). Linear regressions revealed that low baseline CSF 5-HIAA concentrations predicted low intoxication ratings ($B=0.24$, $t(72)=2.04$, $p=.045$), and low CSF 5-HIAA concentrations predicted rapid escape latency ($B=0.61$, $t(18)=3.17$, $p=.006$). Results show that objective measures of intoxication positively correlate with subjective ratings of intoxication, and that both objective and subjective ratings positively correlate with CSF 5-HIAA concentrations, an indication that low CNS serotonin functioning is predictive of low intrinsic sensitivity to the intoxicating effects of ethanol.

Abstract # 56

A BIOGRAPHY OF A WILD-BORN WESTERN LOWLAND GORILLA

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The number of wild born apes that were imported into the USA prior to the passing of the Endangered Species Act (1973) is dwindling rapidly. King, a male, western lowland gorilla (*Gorilla gorilla gorilla*) is estimated to being close to 50 years old (Sharon DuMond, personal communication). While the details surrounding his importation remain unknown, we have documented his early history as a juvenile through conversations and electronic communication with several former circus employees and circus aficionados. King initially performed as part of a stage act in Las Vegas (until 1974) and subsequently became a circus performer at Hoxie Brothers Circus where he was given the stage name Mongo. He was purchased by Monkey Jungle, a small commercial zoo in Miami, from Hoxie Tucker in 1979 and it was immediately apparent that King understood a considerable amount of spoken English (eventually he became bilingual by adding Spanish to his language skills). Because of his history as an entertainer, King was easily trained to perform specific behaviors which were initially incorporated into educational performances for the visiting public. Later they were used to investigate his cognitive abilities including shape and color discrimination, mirror-recognition and his capacity for episodic memory. King is studbook #708 and his training at Monkey Jungle was supported by an American Society of Primatologists conservation award to Lisa Paciulli, 1989.

Abstract # 57

THE RELATIONSHIP BETWEEN 2D:4D AND ADULT ONSET OBESITY IN CAPTIVE VERVET MONKEYS (*CHLOROCEBUS SABAEUS*)

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The ratio of second to fourth digit length of the hand (2D:4D) has been shown to have a negative relationship with prenatal androgen levels and a positive relationship with BMI in human males, but not human females. These relationships may suggest a link between in utero androgen exposure and adult obesity. This project examines the relationship between 2D:4D and obesity in a captive population of vervet monkeys (*Chlorocebus sabaeus*) at Wake Forest School of Medicine. We analyzed anthropometric measures from 58 adults—52 females and 6 males—to determine the relationship between 2D:4D, chronic obesity (CO), and clinical markers of obesity: BMI, mass, and waist circumference. In males, we hypothesized higher 2D:4D when CO, and positive correlations between 2D:4D and clinical markers of obesity. In females, we expected no relationship between these factors and 2D:4D. As expected, we found no significant relationships in females, but found significantly lower 2D:4D in CO compared to non-obese males ($t=3.4132$, $df=2.8751$, $p<0.05$). Previous work suggests exposure to calorically restricted diets in utero is linked to CO in vervet males, but not females; perhaps this dietary effect is more important than presumed prenatal androgen exposure, but this relationship with 2D:4D is puzzling. Further research– and a larger sample size– will be necessary before we can accurately interpret these results.

Abstract # 58

TESTING FOOD PREFERENCES IN ZOO-HOUSED APES WITH TOUCHSCREENS

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Preference testing has many benefits, informing both applied management decisions and theoretical questions. We developed a preference-testing method in which subjects are shown pairs of photographs of food items on a touchscreen in a forced-choice paradigm and rewarded with the food they select. In this paradigm, the relative frequency of selections represents the subject's relative food preferences. We evaluated this method with a zoo-housed male gorilla (*Gorilla gorilla gorilla*). His relative-preferences for four foods (grape, carrot, turnip, and cucumber) were tested in six pairwise tests, with 90 trials per pairing. In pairings in which each of the foods was offered, the subject selected grape in 96% of trials, carrot in 53%, cucumber in 30%, and turnip in 21%. Food pairing had a significant effect on the subject's selection rate for carrot ($p<.001$) and cucumber ($p<.001$), but only for turnip in certain pairings, and not for grape in any pairing. The subject displayed a significant preference for grape, selecting it above chance across food pairings ($p<0.001$), while his selection for other foods varied by pairing, revealing his relative preferences for those food items. These results correspond with the subject's preferences measured previously with a manual preference test and validate that touchscreens can be used to assess primate food preferences. This new methodology is now being implemented with additional gorillas and also chimpanzees (*Pan troglodytes*).

Abstract # 59

BENDING AFTER BREAKING: AN ANALYSIS OF THE STRENGTH PROPERTIES OF LONG BONES IN *SAIMIRI SCIUREUS* FROM MUSEUM CONTEXT USING BONE

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Traumatic injuries to bone are not uncommon in free-ranging primate populations. Our understanding of the healing and strength properties of those bones are limited. This project establishes a non-destructive analysis protocol to evaluate strength property patterns among long bones of Saimiri sciureus (Common squirrel monkey) from museum context. 54 long bones were scanned with x-ray micro-CT and converted into tiff stacks for strength property analysis using the BoneJ plug-in for ImageJ. Paired bones, including one uninjured bone and one bone presenting a healed/healing callous, were scanned when possible. In addition, long bones from individuals with no traumatic injuries were scanned in order to develop baseline values for cortical strength properties. Medial-lateral and anterior-posterior area moments of inertia and polar moments of inertia were calculated at 10% length intervals along the long axis of the bones to determine the resistance to bending and twisting forces, respectively. Callous locations corresponded with increased resistance to bending and twisting forces along with increased cortical thickness in affected segments. However, no clear pattern of statistically significant differences was discerned among pairs of broken and unbroken bones for strength property measures. This protocol yields data directly related to stress factors of locomotion in wild primates through non-destructive techniques and utilizing museum collection. Additionally, these data aid in our understanding of how primates heal from traumatic injuries to bone in the wild.

Abstract # 60

ASSESSMENT OF A NOVEL METHOD OF PHOTOGRAMMETRY NOT REQUIRING LASERS IN PARALLEL

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Remote measurements of size are helpful for studying unhabituated primate populations. Photogrammetry uses photographs as scaled representations from which to accurately measure subjects. Typical photogrammetry methods require costly hand-made parallel laser mounts to establish scale. Here, we test an unpublished method that uses only focal length and subject distance to establish scale. The equation for this relationship is: $S_a=((D*F)/S_p)+C_i$, where S_a is actual subject size, D is distance from the lens, F is lens focal length, S_p is subject size in the photo, and C_i is a correction factor unique to each camera/lens. To calculate C_i, we photographed a ruler at several distances and focal lengths using a Nikon D700. We measured D to within ± 1.6 mm using a Leica DISTO D2 Rangefinder. S_p was measured using Gimp, and subtracted from Sa for measurement error. We regressed error against log(D*F) for all photos to calculate C_i. To validate, we estimated measurement error in photos of a new subject: a field assistant. In contrast to previous findings, mean error was quite large (3000 mm; compared to previous reports of 0 mm), suggesting his method does not reliably give accurate measurements of primate body lengths (in our vervet monkey subject, *Chlorocebus pygerythrus*, sizes range from 25 to 50 cm).

Abstract # 61

SOCIAL NETWORK COMMUNITY STRUCTURE IS ASSOCIATED WITH THE SHARING OF COMMENSAL *E. COLI* AMONG CAPTIVE RHESUS MACAQUES

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In social systems, understanding the dynamics of microbial sharing remains critical for infectious disease control. In nonhuman primates, heterogeneity in social networks is being increasingly modeled to assess such sharing. Here we use phylogenetics and social networks to assess commensal bacterial (*Escherichia coli*) sharing among three captively-housed rhesus macaque (*Macaca mulatta*) groups. Behavioral data on grooming, huddling and aggression were used to reconstruct weighted, undirected, contact-networks using a clustering method – Data Cloud Geometry. Bacterial similarity was inferred by calculating phylogenetic distances between DNA fingerprint profiles generated by processing macaque fecal samples using Pulsed Field Gel Electrophoresis. GLMMs showed that in two macaque groups, pairwise similarity in *E. coli* was higher among young-young (B=4.83, df=3073, p<0.01) and male-male dyads (B=3.83, df=3073, p<0.01), but unrelated to social contact frequencies. At the community level, *E. coli* similarity was significantly greater among macaques within the same compared to different behavioral communities for all three groups (e.g. Group III grooming: D=0.81, p<0.01). Our findings suggest that in spatially constrained, frequently interacting monkeys, microbial sharing may be discernible across clusters of connected community members, rather than between dyads. Future work will aim to link *E. coli* sharing to macaques' shared space-use, and assess microbial transmission by constructing directed networks.

Abstract # 62

A SUCCESSFUL STRATEGY FOR SOCIAL HOUSING ADULT MALE CYNOMOLGUS MACAQUES IN TRIADS

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At Charles River, we are committed to ensuring all animals have the highest level of care and welfare. For juvenile, subadult and adult female cynomolgus macaques (*Macaca fascicularis*), we have a near 100% success rate for social housing. Sexually mature males, defined as 5kg or greater, pose a unique challenge when triads (groups of three) are required by study design. We have developed a successful process to socially house mature males in triads. During the initial introduction, all three males are given grooming access and monitored for compatibility. After a minimum of 48 hours of grooming access, full social access is attempted and begins by evaluating affiliative behaviors towards the male housed in the middle cage. The two animals showing more affiliative behavior are attempted first. After approximately 15 minutes, if mild to no aggression is observed, the third animal is given full access. In 2016 we evaluated 52 triads in this paradigm and 62% were successfully housed at full contact for two weeks or longer. Overall, this system avoids social housing exemptions and improves the welfare for many animals in our facility.

Abstract # 63

EXPOSURE TO NOVEL FEMALES INCREASES TESTOSTERONE LEVELS IN SOCIALLY-HOUSED MALE CAPUCHIN MONKEYS: EVIDENCE FOR THE CHALLENGE HYPOTHESIS

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From birds to primates, the challenge hypothesis has successfully predicted changes in androgen profiles in males. Specifically, the challenge hypothesis predicts that testosterone levels in males will fluctuate due to competition for mates. However, one of the challenges of studying the challenge hypothesis in primates is that it is often difficult to distinguishing between testosterone changes due to increased competition, as the hypothesis predicts, or simply as a byproduct of increased sexual activity. Here, we examine the effects of the introduction of novel females on fecal testosterone levels in 7 socially-housed male capuchin (*Cebus [Sapajus] apella*) monkeys (n=98 fecal samples). We found that males exhibited a drastic increase in testosterone (LMM; beta= 1.88, t= 3.78, p<0.001) within one week of being in visual – but not physical – contact with novel females. Males in neighboring social groups that were in auditory but not visual contact to novel females showed no increase in androgen levels (beta= -0.14, t= -0.26, p=0.79). These results support

they hypothesis that males boost testosterone levels due to anticipated challenges over mating opportunities. In addition, we found that dominant males had higher baseline testosterone levels than subordinate males (LMM; beta= 1.69, t= 2.78, p=0.049), providing strong support for the challenge hypothesis in this taxon.

Abstract # 64

THE RELATIONSHIP BETWEEN SELF-DIRECTED ANXIETY BEHAVIORS AND CORTISOL IN SOCIALLY HOUSED CAPUCHIN MONKEYS (*CEBUS* [SAPAJUS] *APELLA*)

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Non-human primates are excellent models for the study of human social anxiety. Both humans and non-human primates form complex relationships with others, and exhibit signs of distress when those relationships become unstable. Self-directed behaviors, such as self-scratching, have traditionally been used to non-invasively measure stress and social anxiety levels in primates. Surprisingly few studies have correlated anxiety behaviors, such as scratching, with levels of glucocorticoids such as cortisol, which is a well-established biological marker of stress. This study aimed to determine whether stress-related behaviors are correlated with cortisol hormone levels in socially housed capuchin monkeys (*Cebus* [Sapajus] *apella*). To assess the relationship between stress and scratching behavior, we conducted 32.8 hours of observation and collected 103 fecal samples from 21 capuchin monkeys. Initial results suggest that individuals with higher average cortisol levels scratched more often than those with lower circulating cortisol (Spearman's Rho=0.46, p=0.04), We found that status significantly influenced both cortisol levels (Mann-Whitney *U*=23, z=-2.2, p=0.028) and scratching behavior (Mann-Whitney *U*=19, z=-2.03, p=0.041). Lower-ranking monkeys had higher baseline cortisol and scratched more often than higher-ranking individuals. These results suggest that scratching behavior in capuchins is a viable marker of baseline stress.

Abstract # 65

BEHAVIORAL PREDICTORS OF SUCCESSFUL PAIRING OF RHESUS MACAQUES (*MACACA MULATTA*) AT THE VISUAL CONTACT PHASE OF SOCIAL INTRODUCTION

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Identification of behaviors early in the process of rhesus macaque social introductions that might predict social housing success would allow primate managers to best allocate resources and minimize animal stress by aborting introductions unlikely to lead to successful pairings. We compared behavior during the initial visual contact phase of social introductions in pairs later determined to be successful (e.g., maintained 14+ days, prosocial behavior, no frequent minor and no major wounding, no resource monopolization) to unsuccessful pairs. Each unsuccessful pair (n = 53) was matched with a successful pair (n = 53) on sex (26 male, 80 female) and approximate age (range 1.9 - 16.8 years, matched within one year). A conditional logistic regression with the presence/absence of seven behaviors (lunge, avoid-withdraw, lipsmack, present, enlist/co-threaten, fear, anxiety) as the predictors of pairing success showed statistical significance (λ (df = 7) = 14.979, p = .036); only one individual predictor was significant. Pairs observed lunging were less likely to be successfully pair housed (Wald λ (df = 1) = 9.274, p = .002, odds ratio = .130). In 42% of the matched pairs, monkeys in the successful pair lunged, while those in the unsuccessful pair did not. In contrast, the reverse happened in only 6% of the matched pairs. Results suggest caution for progression past the visual stage of social introductions when lunging is observed.

Abstract # 66

MANAGEMENT OF WEIGHT AND BODY CONDITION FOR CAPTIVE ADULT AND AGING CHIMPANZEES (*PAN TROGLODYTES*)

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With the goal of finding a practical way to improve and/or maintain the body condition of overweight chimpanzees to promote health and welfare, several feeding protocols' effects on chimpanzee body condition scores (BCS) were evaluated. BCS were assessed at the start and finish of each study phase, and individuals were categorized as Average (BCS 4-6) or Overweight/Obese (BCS>6). Phase One feeding protocol increased amounts of leafy greens provided but maintained groups on unlimited primate biscuits. A Wilcoxon Signed-Ranks test found no significant change in BCS for Average (N=10) or Overweight/Obese (N=18) chimpanzees after one year on this protocol. Phase Two protocol transitioned four subjects to individually-fed, restricted amounts of primate biscuits based on nutritional recommendations; three Overweight/Obese chimpanzees had improved BCS and one Average BCS subject had maintained by the end of six months. There was no significant change in BCS for the remaining chimpanzees in Average or Overweight/Obese categories still on the Phase One protocol (N=23) for a total of 18 months. Phase Three protocol transitioned 11 chimpanzees to restricted amounts of group-fed chow and after 2 months, Average subjects (N=4) maintained their BCS while Overweight/Obese subjects (N=7) had significant improvement (Z=-2.00, p=.45). Twelve chimpanzees still group-fed unlimited chow had unchanged BCS during this timeframe. Behavioral data are currently being analyzed for chimpanzees on different feeding protocols to determine impacts on activity and welfare.

Abstract # 67

DAMS' SOCIAL BEHAVIOR AND LONG-TERM CORTISOL PROFILES IN RESPONSE TO THEIR INFANTS BEING NURSERY-REARED

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The influence of early rearing experiences on infants' social and neuroendocrine development is well characterized. However, little is known about the effects of nursery rearing (NR) on the infants' mothers. Such information is important in welfare considerations. In a two-part study, we examined rhesus monkey (*Macaca mulatta*) dams' social behavior and long-term cortisol responses to their infants being NR or mother-reared (MR). In Study 1, n=27 socially-housed females (NR:n=16, MR:n=11) were observed 30 days before and 30 days after their due date 3x/week in 5-min focal sessions to determine frequencies of positive (e.g., social contact, grooming) and negative (e.g., threat, chase) social behavior, and abnormal (e.g., self-directed) behavior. Paired t-tests revealed that MR dams showed an increase in positive ($t(10)=-4.85, P<0.01$) and a decrease in negative ($t(10)=2.31, P=0.043$) social behavior after their infants' birth whereas NR dams showed no change. No group differences in abnormal behaviors emerged. In Study 2, hair cortisol concentrations (HCCs) of n=46 females (NR:n=15, MR:n=25, not pregnant:n=6) taken every three months from pregnancy through peak lactation were examined. Repeated measures ANOVA revealed that only during peak lactation were HCCs highest for MR dams ($F(2,86)=3.44, P=0.012$); no other group or time effects emerged. We conclude that NR is not detrimental to the welfare of rhesus monkey dams. This research was supported by the Division of Intramural Research at NICHD, and by NIH Grant #OD011180.

Abstract # 68

VALIDATING WELFARETRAK® AS A TOOL TO IMPROVE THE WELFARE OF INDIVIDUAL CHIMPANZEES

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WelfareTrak® is a web application that gives animal care specialists the opportunity to complete weekly species-specific surveys to monitor positive and negative indicators of welfare for individual animals. WelfareTrak® generates reports and “flags” potential shifts in welfare status. The goal of the study was to validate a chimpanzee (*Pan troglodytes*) survey designed by a panel of experts, using behavioral and physiological measures. For a three month Baseline Period, we collected 30-min focal observations three times per week and daily fecal samples from 41 subjects representing 16 institutions; followed by six months of continued data collection while using WelfareTrak®. During the Baseline Period, behavioral diversity was 0.30 (Shannon’s H, range 0.27-0.33, N=38), and was negatively correlated with fecal glucocorticoid metabolite (FGM) concentrations, $r(36)= -0.27$, $p<0.05$, suggesting that behavioral diversity may be a useful indicator of welfare. Preliminary data from the WelfareTrak Period show that FGM concentrations were predicted by survey items “social behavior,” $R2= 0.132$, $F(13, 42)= 4.016$, $p= 0.024$, and “calm/relaxed,” $R2= 0.150$, $F(13, 42)= 4.673$, $p= 0.014$, suggesting construct validity of some survey items. The percent of time spent behaving abnormally was predicted by “performs self-directed behavior (SDB),” $R2= 0.197$, $F(13, 42)= 5.767$, $p= 0.006$. We aim to demonstrate that individual welfare can be improved by monitoring with WelfareTrak®.

Abstract # 88

PRESIDENT'S FORUM: SUPPORTING AND ENHANCING PEER REVIEW

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Scientific peer review is essential. At its best, it improves the quality of papers submitted, improves the work through the review process, and detects fraud and plagiarism. Peer review results in better science. Expert curation is needed now more than ever – with public confidence in science and data eroding (e.g., recent polls erroneous in their predictions of the Brexit and U.S. election results), high profile retractions, and conflicts of interests. We need to retain quality reviewers, but also attract, develop, and encourage the next generation of reviewers. We recognize that primatologists generally receive limited professional training on peer review. The prevailing approach (and not just in primatology) seems to be that if you are a scientist and have published, then you are qualified to be a reviewer. Additionally, reliability, efficacy, and potential bias are topics of controversy. If we believe that peer review is central to our science and results in advancing our field, then we need to improve the efficiency of peer review through training and identifying best practices. This forum is designed to begin the conversation concerning the peer review system for primatology and will focus on identifying best practices in peer review, and implicit bias in scientific publishing. The forum will feature panel presentations and group discussions to foster an open dialogue on these issues.

Abstract # 92

BEHAVIORAL AND PHYSIOLOGICAL OUTCOMES IN NURSERY-REARED PIGTAILED MACAQUES (*MACACA NEMESTRINA*)

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The Infant Primate Research Laboratory at the Washington National Primate Research Center incorporates a number of rearing techniques aimed at assuring the welfare and enhancing behavioral outcomes for infants reared in the nursery. We recently instituted full-time peer group social housing at 2 months of age (n=12) and assessed the impact on behavioral development compared to our older socialization method which began full-time housing at 6 months of age (n=14). Data were gathered when animals were juveniles, housed together in large social groups. We found no significant differences between the two groups and neither group exhibited excessive clinging or aberrant behavior. We also compared the behavior of nursery-reared (n=12)

and mother-reared (n=12) young adult females housed in groups at our Arizona breeding facility. The only significant behavioral difference was that nursery-reared animals spent more time drinking (p=0.002). Comparison of hair cortisol levels between nursery-reared (n=18) and mother-reared (n=48) infants revealed that hair cortisol was significantly lower in nursery-reared animals during the first year of life (p=0.001). However, there were no significant hair cortisol differences between nursery-reared (n=12) and mother-reared (n=12) young adult females (p>0.05). These data indicate that nursery-reared animals can evince normal behavioral repertoires when housed in groups and differences in cortisol between nursery- and mother-reared animals seems to be transient. Funded by P51 OD010425 and R24OD01180-15.

Abstract # 93

NURSERY REARING MACAQUES- AN OVERVIEW FROM A VETERINARY PERSPECTIVE

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A variety of clinical and research scenarios require nursery rearing of infant macaques. Nursery rearing practices vary across institutions and are conducted with a range of personnel and facility resources. Caretakers, veterinarians, research and behavioral staff work together to ensure minimal impact on the health and well-being of non-mother raised infants. An overview of feeding and housing protocols will be presented, focusing on reasonable standards of care. Challenges in clinical management, socialization and biosecurity will also be addressed.

Abstract # 94

TRAINING NON-LACTATING RHESUS MACAQUES TO ACT AS FOSTER MOTHERS

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There can be psychological and physiological consequences resulting from nursery rearing rhesus macaques. To reduce the need for nursery rearing, orphaned infants are often placed with lactating foster mothers. Unfortunately, a supply of these lactating females is not readily available at most institutions. We implemented a program using operant conditioning to train non-lactating rhesus macaques to act as “foster mothers” to abandoned or orphaned infants. Females chosen for specific temperamental traits (e.g., boldness) were trained to allow the infants to bottle feed cage-side. We have successfully fostered 27 infants with 11 foster dams (89% success rate). Foster-reared (FR) infants were fed following the same schedule as nursery reared (NR) infants, and remained with the foster dam until approximately one year of age. We compared clinical and behavioral outcomes of FR infants with 15 NR infants. There were no differences in weight gain (birth to 1 year; t=0.34, df=38, p=0.74) or illness (chi square= 0.86, df=1, p=0.35) between FR and NR infants. However, foster-reared infants were less likely to develop stereotypical behaviors than NR infants (chi square=7.0, df=1, p=0.008); to date, none of the FR infants have developed behavioral issues. Utilizing trained foster mothers provides an alternative nursery rearing, thereby improving overall welfare for macaque infants.

Abstract # 95

COMPARING ABNORMAL AND FEAR-RELATED BEHAVIOR UNDER TWO NURSERY REARING CONDITIONS FOR INFANT RHESUS MACAQUES

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Two nursery rearing strategies for infant rhesus macaques (*Macaca mulatta*) were compared to measure effects on abnormal and fear-related behavior. Changes made from the standard nursery-rearing procedures (SN) included earlier exposure to peers, frequent peer-group play sessions, the use of semi-mobile artificial surrogates, and rotational pairing in the alternative nursery (AN). A variety of abnormal behaviors and fear-related behavior was recorded using one-zero sampling three to five times weekly, until subjects were about one-year old. Thirty-nine percent of the infants (N = 56) developed at least one type of abnormal behavior by 6 months old, and this rose to 55.4% by one year of age. The AN had a lower percentage of individuals with abnormal behavior at one year of age (12.5%, 1/8 animals), compared with 62.5% (30/48 animals) in the SN (Fisher's Exact Test, p = .017). Self-oral behavior was seen in 88.7% (n=53) of the subjects, with no difference in prevalence between nurseries. Fear-related behavior was observed in 17.9% of the infants and did not vary between the nurseries. This analysis provides evidence that nursery-rearing procedures can be important in preventing or reducing the expression of some abnormal behavioral patterns in young rhesus macaques, although perhaps not in fear-related behavior. New practices evaluated in the published literature are being effectively applied to improve the welfare of nursery-reared infant macaques.

Abstract # 96

LONG TERM BEHAVIORAL AND CLINICAL OUTCOMES FOR NURSERY REARED MACAQUES

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Nursery rearing (NR) as an experimental manipulation has informed our understanding of the basic bio-behavioral mechanisms of development. Nursery rearing also occurs for clinical support of infants that fail to thrive or are rejected by their mothers. Early experimental studies developed NR methods that provided for early infant psychological needs through supportive environments; however, variation occurs in aspects of rearing depending on need, purpose and facility. Therefore, in order to inform and improve current practices, it is necessary to assess how NR may modify long-term health and behavioral outcomes for the animals. We reviewed data from NR animals at the WNPRC over the last five years. The purpose of this study was to compare nursery animals to mother reared counterparts from the same birth cohort on measures previously described in the literature as potential precursors of untoward outcomes. Demographic variables will include: the reason the animal was placed in the nursery, along with duration of their stay and handling while in the nursery. Long-term outcome variables include: social history, number of housing changes, reports of abnormal behavior and incidence of diarrhea. Together these data will inform general care practices, future strategies and decision making for nursery animals that have been identified in previous studies as 'at risk' for social deficits and abnormal behavior. Supported by P51OD011106.

Abstract # 99

INVESTIGATION OF GROOMING INTERACTIONS AMONG URBAN-DWELLING RHESUS MACAQUES (*MACACA MULATTA*) IN SHIMLA (NORTHERN INDIA)

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There is increasing evidence that the growing expansion of human settlements has a profound impact on animals. Here we explore whether the frequency of human-monkey interactions affects grooming behavior in three groups of rhesus macaques in Shimla (India): Two which live nearby Hanuman temple and experience high levels of human-monkey interactions, while one group inhabits a Mall area and engages in low levels of interactions with people. We predict that grooming interactions among temple monkeys should be shorter and characterized by higher frequency of vigilance than grooming interactions among Mall monkeys. Our GLMM analyses conducted on 2948 bouts from 88 individuals showed that Mall monkeys engage in significantly longer grooming bouts than temple monkeys (t =2.17, p = 0.030), while among only temple monkeys grooming interactions were significantly longer in locations away from the temple than in the temple area, where most of the human-monkey interactions occur (t = 2.37, p = 0.018). Furthermore, we found that temple

monkeys displayed higher rates of vigilance during grooming when they were at the temple than in non-temple areas ($t = 6.177$, $p < 0.001$) and compared to grooming interactions among Mall monkeys ($t = -3.21$, $p = 0.001$). Since grooming has important social and hygienic functions, our work highlights the possibility that the negative influence of human presence on grooming can have important implications for monkey health.

Abstract # 100

DETERMINANTS OF HUMAN-NONHUMAN PRIMATE CONFLICTS IN LONG-TAILED MACAQUES (*MACACA FASCICULARIS*) IN MALAYSIA

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With an ever-growing human population, interactions between humans and nonhuman primates in shared interfaces are common and can lead to a variety of types of conflict (e.g., stealing goods and crop raiding generating financial losses; severe physical aggressions generating health risks). Disentangling the drivers of such conflict remains critical to their mitigation. Recent studies, however, have mainly focused on general patterns of interactions neglecting inter-individual differences. To address this gap, we assessed the drivers of conflict with humans among three groups of urban dwelling long-tailed macaques in Malaysia. Individual factors such as dominance rank and sex as well as within group aggression patterns are recorded and evaluated as potential drivers of conflict. Preliminary analysis of 273 inter-species aggressive events collected during focal follows of 74 macaques indicated that primate-to-human aggression was mainly influenced by the monkeys' sex, with males being more aggressive towards humans than females ($t(3)= 3.92$, $p < 0.001$). Male, compared to female, macaques also tended to be aggressed more frequently by humans ($t(3) = 1.74$, $p=0.08$). In contrast, neither dominance rank nor their propensity for aggression towards other monkeys significantly predicted human-macaque aggressive interactions. Ongoing research will address untangling the dynamic interplay between these aggressive encounters and assess whether human-macaque interactions are influenced by suites (rather than single) of attributes (e.g. human socioeconomic status, macaque personality).

Abstract # 101

POPULATION GENETIC ANALYSIS OF BLACK-AND-WHITE RUFFED LEMURS (*VARECIA VARIEGATA*) IN RANOMAFANA NATIONAL PARK, SOUTHEASTERN MADAGASCAR

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Habitat loss and fragmentation are among the greatest extinction threats to species worldwide. Large, continuous tracts of forest- such as those found in national parks- are considered crucial for protecting biodiversity and maintaining population cohesion and genetic variability across taxa. We sought to determine the efficacy with which a national park maintained genetic structure and diversity within the Critically Endangered black-and-white ruffed lemur (*Varecia variegata*). To achieve this, we collected 97 fecal samples from adult *V. variegata* at four locations within Ranomafana National Park (RNP) and identified 38 individuals using a suite of ten microsatellite markers. These data was used to evaluate genetic diversity and population genetic structure, as well as to test for evidence of population bottleneck signal. Both a Bayesian cluster analysis and a multivariate clustering method provided evidence for one genetic population within RNP. Mean number of alleles per locus was 4.00, and observed and expected heterozygosity were 0.628 and 0.624, respectively. These levels of genetic variability are similar to a previous study performed within the park, albeit lower than in several other lemur taxa. Additionally, evidence for a recent population bottleneck was found under all three mutation models assessed. Together, these results suggest that RNP has been successful in maintaining gene flow in *V. variegata*, although this population may have suffered a recent decline in

population size and genetic diversity.

Abstract # 102

UNHABITUATED CHIMPANZEES (*PAN TROGLODYTES*) IN THE HIGHLANDS NORTH OF GOMBE NATIONAL PARK, TANZANIA

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To assess the population of chimpanzees living outside Gombe National Park, Tanzania, we conducted surveys of village lands 10 — 20 km north of the park (5-9 October 2015 and 4-10 May 2016), integrating these findings with data from DigitalGlobe satellite images and community forest monitoring data. Surveys recorded the number and GPS location of chimpanzee nests, fecal samples, and sightings, preserving fecal samples in RNAlater. In 2015, we found 183 chimpanzee nests, 3 fresh fecal samples, and saw 3 parties of chimpanzees, including one with ≥ 5 individuals. From 2012-2016, village forest monitors reported 138 nests, heard chimpanzees 10 times, and saw chimpanzees 3 times. The 2015 fecal samples tested negative for SIVcpz, and were from at least two previously uncharacterized individuals. In 2016, surveys found 7 chimpanzee nests and 2 sites with fecal samples, but did not see chimpanzees. These two surveys and community data both found that chimpanzees persist near the park. Nonetheless, it was evident from both satellite images and surveys that people are rapidly converting forest and woodland to farms. While these areas have been established by communities as Village Forest Reserves, new actions and resources are needed to enforce village land use plans and ensure the protection of these chimpanzees and their habitats.
Funding: University of Minnesota; NIH grants R01 AI120810 and P30 AI045008; DigitalGlobe, ESRI, Google, USAID, and JGI.

Abstract # 103

HABITAT DEGRADATION AND PROXIMITY TO VILLAGES EXPLAIN GENETIC COMMUNITY STRUCTURE IN A CRITICALLY ENDANGERED LEMUR SPECIES.

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Madagascar's biota is characterized by exceptional species diversity, much of which is threatened by habitat fragmentation due to human land use practices. Black-and-white ruffed lemurs (*Varecia variegata*) are Critically Endangered primates that thrive almost exclusively in primary rainforest habitats. Recent studies have found geographic variation in the genetic distance and diversity among populations; however, the primary landscape drivers of these observed phenomena have not been discerned. Landscape genetic analyses - which use spatial modeling to identify how landscape features affect distribution of genetic variation - are useful to clarify these uncertainties. We employed a new landscape genetics approach that optimizes resistance surfaces using genetic algorithms to evaluate the impacts of natural and anthropogenic factors on genetic distance among 18 *V. variegata* sampling localities throughout Madagascar's eastern rainforest

corridor. Resistance surfaces were optimized for five landscape features and the best surface was chosen using Akaike information criterion (AIC). Our results indicate that a composite surface including proximity to villages and habitat type (AIC = -450) explained significantly more variation in the observed genetic structure in *V. variegata* than geographic distance (AIC = -433), as well as either surface independently (AIC = -442 and -446, respectively). These results demonstrate that human activity has significantly impacted the genetic structure of this Critically Endangered lemur and highlight the need for habitat restoration in areas of high conservation value.

Abstract # 105

THE ROLE OF PUBLIC RELATIONS IN PRIMATE CONSERVATION: EXAMPLES FROM UGANDA

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Within developing countries primate conservation is not only important locally in communities neighboring primate habitats, but is also critical at the national level because all citizens have the ability to influence conservation decisions for the country. While local community engagement typically features in conservation programs, people geographically distant from primate habitats are often uninformed about biodiversity and economic benefits of protecting primates. For example, ecotourism is now the largest foreign income earner in Uganda, but few citizens know the threats facing primates. Here, we outline three examples of successful ongoing public relations campaigns to promote conservation of primates and other wildlife at the national level. First, a tour with journalists and politicians spanning a few days a month was launched to explore protected areas, highlight their significance in the mainstream media, and encourage tourism by Ugandan citizens. Second, intramural sports teams were organized among the police, military and wildlife authority to encourage positive exchange and mobilize additional government support for conservation. Third, national participation in international wildlife events through school programs in cities, sports events (e.g., wildlife marathons), public lectures and city exhibits emphasized the important role Uganda plays in hosting a good portion of the world's biodiversity. This public relations approach provides a new dimension to primate conservation, and highlights the importance of integrating the public into primate conservation nationwide.

Abstract # 106

THE PERCEPTION OF MACAQUES' MINDS IS RELATED TO ATTITUDES ABOUT MACAQUES AT INTERFACES

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As human populations increase in size, interactions between humans and nonhuman primates in shared interfaces also become more frequent leading to the potential for conflict. Little attention has been paid to human psychological processes that may influence conflict dynamics. We evaluated human attitudes about rhesus macaques (*Macaca mulatta*) and perceptions of macaques' capacity for experience and agency (ascribing "mind" to them) at interfaces in Northern India after people had an interactions with a macaque or not (N=210). Overall, participants who more strongly endorsed the acceptability of visiting interfaces to see and feed monkeys reported that chasing and hitting monkeys was less acceptable [$r(210)=-0.199$, $p=0.004$]. Those who attributed more mind to monkeys also reported that visiting and feeding them at interfaces was more acceptable [$r(210)=0.20$, $p=0.003$]. Mind perception, however, did not influence reported acceptability of chasing or hitting monkeys at interfaces [$r(210)=0.04$, $p=0.57$]. The extent to which participants liked monkeys also predicted endorsing greater acceptability of visiting and feeding [$r(207)=0.43$, $p<0.0001$] and less acceptability of chasing or hitting [$r(207)=-0.14$, $p=0.046$], as well as greater ascription of mind to them [$r(207)=0.29$, $p<0.0001$]. Implications for using strategies to effect human attitudes and perceptual change as tools to manage human-macaque conflict will be discussed.

Abstract # 108

ORANGUTAN STRATEGIES FOR SOLVING A VISUOSPATIAL MEMORY TASK

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The Concentration Game, in which players search for matching pairs among a grid of face-down cards, provides a robust platform for examining visuospatial memory in a simple, nonverbal way. Orangutans(n=5) at the Indianapolis Zoo were given a modified version of the game in which three cards were shown face-down on a computer screen, two of which matched while the third was a foil. Subjects overturned two cards at a time by touching them, with trials terminating in a food reward if the cards matched, or reverting face-down positions if they did not. A constraint was imposed on the game whereby the first two cards touched would never match, resulting in an optimal search strategy composed of touching the first two cards, followed by the third, followed by the card among the first two that matched the third. Findings showed that three of five subjects utilized the optimal search strategy more often than was expected by chance(binomial tests, $p < .05$), but also perseverated on specific patterns of choice sequences rather than flexibly adjusting behavior from trial to trial to minimize the overall number of card flips. The observed tendency of orangutans to rely on a prescriptive choice strategy instead of adaptively updating their solution in light of evidential developments is consistent with findings from prior studies on orangutan strategies for solving invisible displacement tasks.

Abstract # 109

INFANT RHESUS MACAQUES (*MACACA MULATTA*) INTERPRET REACH-GRASP ACTIONS AS GOAL-DIRECTED

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Recent studies suggest that adult rhesus macaques interpret actions as goal-directed – that is, they expect agents to act in an efficient manner to achieve a goal. In humans, this teleological stance emerges around 12 months old. Is goal understanding foundational to monkeys' action understanding and therefore an early-emerging cognitive achievement? To test when goal-directed action understanding develops, we familiarized 27 six-month-old infant rhesus macaques (16 female) with a video in which a familiar caretaker reached over an obstacle to grasp a toy. To check whether the mere presence of the barrier affected infants, in the control condition the caretaker executed the same reach and grasp action, but the obstacle was situated behind the toy. Following familiarization, the obstacle was removed and infants saw the caretaker reach and grasp the toy i. in a straight line, or ii. following the same curvilinear path that was taken to avoid the obstacle. Using Tobii eyetracking technology, we measured the total duration of fixations to both test events. Results show that in the experimental condition, infants looked significantly longer at the curvilinear trajectory than the straight trajectory ($t(26)=3.04$, $p=0.005$), but they did not discriminate between the two types of reaches in the control condition ($t(26)=-0.62$, $p=0.54$). These results suggest that for rhesus macaques, goal detection and understanding emerge early in life and may be foundational for intentional understanding.

Abstract # 110

A TOKEN-TRAINED CAPUCHIN (*CEBUS APELLA*) NAMES WHAT HE HAS SEEN BUT LOOKS FIRST AT WHAT HE HAS NOT SEEN

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Metacognition, or knowing what you know, is often assessed through an information-seeking paradigm in which an animal can act to gain more knowledge about a situation before making a decision. We tested for information seeking in two captive brown capuchin monkeys that had learned to associate particular tokens with particular foods. They were trained that when a food item was visible and they were presented with two tokens, they received the food item if they selected the token that was associated with that food. We tested for information seeking by hiding a piece of food in a cup and holding it above the monkey's head during token selection trials. On some trials the monkey would be shown the food item before it was raised and others not. If the monkeys sought information, they could climb up the caging and look in the cup on unseen trials before making a token selection and would not need to look on witnessed trials. One monkey looked into the raised cup more than expected when he was not knowledgeable about the contents and looked less than expected when he was shown the contents of the cup before it was raised, Chi-square(1,60)=24.31, p<.001. The second monkey tested never sought information about the contents of the cup. Results provide evidence for information seeking in a brown capuchin monkey.

Abstract # 111

STRATEGIC DECISION-MAKING IN CAPUCHINS (*CEBUS APELLA*), RHESUS MONKEYS (*MACACA MULATTA*), AND HUMANS DURING A COMPETITIVE TWO-PLAYER GAME

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As social animals, primates need to cooperate with each other to reap the benefits of living in a group. Individuals within a group, however, have competing interests as they fight over resources. We used a competitive game to investigate decision-making in a situation in which it pays to be unpredictable (to avoid exploitation) but to be able to predict another's moves (to gain an advantage). Twelve capuchins, four rhesus monkeys, and 80 humans played in pairs against each other by each choosing between two options on a computer screen. One player was rewarded when both selected the same target, whereas the other player was rewarded when they chose opposite targets. Both humans and monkeys met game-theoretic predictions in the symmetric game, in which players should select between the two options randomly in order to maximize gain (no deviation from predictions; humans: chi-square(1) = 1.03, p = .311, monkeys: chi-square(1) = 1.34, p = .248). However, the asymmetric game required one of the players to choose between options at a 25:75 ratio. Monkeys adjusted their strategies in the expected directions (chi-square(1) = 0.11, p = .740), whereas humans again played 50:50 (deviating significantly from equilibrium predictions: chi-square(1) = 80.06, p < .001). These results suggest that, in a competitive context, humans may favor acting unpredictably to win a given round over maximizing overall gain.

Abstract # 112

SQUIRREL MONKEYS (*SAIMIRI SCIUREUS*) PERFORM SIMILARLY TO OTHER NEW WORLD MONKEYS AND PROSIMIANS ON A TOOL USE TASK

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Two-choice tool tasks have been used to test tool comprehension in a number of tool-using and non-tool-using primate species. Though spontaneous tool use was recently documented in a captive group of squirrel monkeys, tool comprehension has not been further studied in the species. We present data from two tool-pulling choice tasks with squirrel monkeys. In Experiment 1, subjects (n=6) were presented with a choice between two wooden rakes (one baited, one unbaited) to obtain an out-of-reach reward. Five subjects spontaneously pulled the baited rake over the unbaited rake (criterion: choosing the baited rake in 17 trials over two consecutive 10-trial sessions; mean sessions to criterion=2.83, SD=2.04). The food likely enhanced the salience of the baited rake, and as the rake handles were inserted into the enclosure at the beginning of each trial, subjects could use a natural pulling motion to receive the reward. In Experiment 2, subjects (n=6)

were presented with a choice between two canes, one effectively baited and one ineffectively baited. Subjects were required to reach outside of the enclosure to manipulate the tools and pull in the bait. On average, subjects required 9.67 sessions (SD=4.23) to reach criterion (two consecutive sessions choosing the effectively baited cane in 10 of 12 trials). Experiment 2 performance was comparable to learning curves previously reported for New World monkeys and prosimians on the same task.

Abstract # 114

IDENTIFYING DISTINGUISHING FEATURES OF PERCEPTUOMOTOR CONTROL OF STONE TOOLS IN HUMANS AND BEARDED CAPUCHIN MONKEYS

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The manufacture of flaked stone tools from about 2.5 Mya profoundly altered the course of human evolution. We propose that differences in perceptuomotor cordination in humans compared to other primates contributed to this transition. In the present study, using kinematic analysis of video records, we compared patterns of variability in movements while cracking palm nuts (*Astrocaryum* spp.) among wild bearded capuchin monkeys, *Sapajus libidinosus* at Fazenda Boa Vista, Brazil, that routinely crack these nuts, and humans—novices (scientists) and experts (residents). The monkeys struck a nut repeatedly with consistent moderate force and consistent movements. The residents regulated their body movements after an initial strike and subsequently struck the nut with the kinetic energy adequate to crack it open in one or two more strikes. They showed the largest variability in movements. The scientists employed neither strategy. They produced an intermediate variability in movements and the largest variability in performance (all mentioned contrasts $p < 0.05$, mixed effect Poisson regression analyses). These results suggest humans regulate kinetic energy of the stone, an integrated property of the stone's mass and its velocity, whereas monkeys regulate amplitude and velocity of their strikes, which can be perceived through kinesthesis. Extending kinesthesis to include properties of objects in motion may have enabled our ancestors to discover effective movement solutions for knapping stones, and for other instrumental actions with objects.

Abstract # 115

DISCRIMINATION OF SEX IN CAPUCHIN MONKEYS (*CEBUS* [SAPAJUS] *APELLA*)

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Several species of nonhuman primates (NHPs) extract information about individual identity from faces alone, however little is known about whether NHPs extract other social information, such as the sex of the conspecific, which is fundamental to their reproductive success. Although previous research in the visual domain is limited, it suggests that conspicuous sexual features, in addition to faces, may play an important role in sex categorization. Yet unlike the species previously tested on sex discrimination tasks (e.g., macaques and chimpanzees), many New World species, including capuchin monkeys, do not show conspicuous sexual features. Capuchins nonetheless display dimorphism in facial morphology suggesting that they may deduce the sex of an individual from facial morphology alone. Using a computerized dichotomous choice task, I tested whether capuchin monkeys (n=14) categorized the sex of conspecifics from faces alone and whether familiarity aided performance. Overall, the capuchins did not perform above chance on the sex discrimination task and no effect of familiarity was observed (ANOVA: $F_{2,24} = 0.435$, $p = 0.562$). However, the four subjects that did not exhibit a side bias chose “male” significantly more often when a male photo was presented than when a female photo was presented. (McNemar Test: $\chi^2 = 36.029$, $p < 0.0001$). Although some capuchins may have learned the task, it seems likely that capuchins discriminate sex through alternative, or multiple, modes of communication.

Abstract # 116

THE EFFECTS OF POSITIVE AND NEGATIVE EXPERIENCES ON SUBSEQUENT BEHAVIOR AND COGNITION IN CAPTIVE CAPUCHIN MONKEYS (*CEBUS APELLA*)

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While it is known that acute and chronic stress can impact cognition in a range of species, less is known about the immediate impacts of minor frustration or positive experiences on subsequent behavior and cognition in a primate model. The current study used a novel methodology to engineer both positive and (slightly) frustrating experiences, using the same apparatus, in 15 adult capuchin monkeys. After the positive or negative experience (or a control condition with no manipulation), subjects were presented with a delayed match-to-sample (DMTS) task for 30 minutes to assess working memory (6 sessions for each condition). As predicted, experiencing a frustrating task prior to testing resulted in a decrease in performance on the DMTS compared to after a positive experience (LMM: b=0.02, SE=0.01, z=2.80, p=.015) or the control (b=0.03, SE=0.01, z=3.32, p=.003). However, contrary to predictions, a positive experience did not facilitate performance to higher levels than the control condition. Additionally, behavioral analysis indicated increased levels of scratching, commonly used as an indicator of stress, after the negative experience compared to both the positive experience (GLMM: b=-0.08, SE=0.03, z=-3.04, p=.002) and the control (b=-0.09, SE=0.03, z=-3.10, p=.002), but no difference between positive and control conditions. These results indicate that negative experiences, even minimally frustrating ones, impact subsequent behavior and cognition in primates, but that there may not be an enhancing effect of positive experiences.

Abstract # 117

INDIVIDUALITY AND STABILITY OF COMMON MARMOSET MOBBING CALLS

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At least four New World primate species have individually distinct long calls, but this distinctiveness is not necessarily stable over time. Individually distinct mobbing calls have been demonstrated for three marmoset species but there has been no assessment of the stability of these differences. We recorded the *tsik* calls of six captive adult marmosets (*Callithrix jacchus*) in response to snake models at two time points six months apart. We measured eight acoustic variables including duration, inter-call interval, number of harmonics, minimum and maximum frequency, and starting, maximum, and ending peak frequency. Discriminant function analyses confirmed that calls recorded at the first time period (summer 2014) were individually distinct [82.48% correctly classified, $X^2(40)=2362.05$, $p<.001$]. Stability of the calls was assessed using the DFA model for summer 2014 to classify calls elicited in winter 2015. The classification rates were lower, although still more than would be expected by chance [62%, $X^2(25)= 954.60$, $p<.05$]. However, all six marmosets showed significant changes in at least four (out of eight) acoustic parameters during that six month period, and all eight parameters changed in two marmosets. In such a short time period, these changes in the acoustic structure of the *tsik* calls are unlikely due to changes in vocal tract morphology or other physical features of the marmosets, but instead may be linked to social changes within the groups.

Abstract # 118

ASPECTS OF VISUAL ATTENTION IN PRIMATE SOCIAL FORAGING

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This study examined how primates shift the focus of their attention to discover new resources and to navigate skillfully within their social field. Primates typically forage within a complex social-ecological context, and the constraints and opportunities afforded are different for each individual. Field observations suggest that animals register the layout of pathways, potential feeding sites, and the movements of group members almost constantly during their daily ranging. At any moment, the vast majority of impinging stimuli are in the background of attention, but salient events can grab attention and cause a rapid reorientation of behavior. Discovery of food is one such event. A social group of 10 tufted capuchins (*Cebus* or *Sapajus* spp) were presented with trial-unique food-finding problems in an open field. The group was video recorded prior to and after food discovery. Animals detected another's manual grasping of food exceedingly quickly. Onlookers discriminated between discovery and mere searching without finding. Animals possibly used the oriented movements of others to discriminate the precise food location. Over minutes, the focus of search activity shifted from the initial food location to surrounding environmental structures, including structures of the same general type. Responses following the detection of food varied sharply across individuals, in ways that tended to provide an advantage to the individual in its particular social and ecological situation. Supported by HD060563.

Abstract # 119

BEHAVIORAL RESPONSES TO INEQUITY IN RESEARCH OPPORTUNITIES IN GORILLAS (*GORILLA GORILLA*) AND ORANGUTANS (PONGO SPP) AT THE SMITHSONIAN'S NATIONAL ZOO

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Cognitive studies typically focus on an animal's performance on a task. When we take into consideration behavioral responses to research activities, our understanding of the complexity of their world becomes richer. To isolate cognitive abilities from the confounding factor of group influences, individuals are often separated from their group for testing. The interactions of participants when reunited with their group can indicate if inequity of research opportunities alters social behavior. Inequity studies in non-human primates show a strong behavioral response when the value of primary reinforcers from one participant to another is unequal. To identify if gorillas and orangutans respond to inequity in research participation (and food reward) opportunities when non-participants could see or hear sessions, we compared the behavioral responses (aggressive, submissive, affiliative, and neutral) of gorillas (n=6) and orangutans (n=5) at the Smithsonian's National Zoo during their first interaction following release from voluntary separation for research activities. Preliminary data suggest the behavior upon return to their group differed based on equity for gorillas ($\chi^2(3)=20.42$, n=113 sessions, $p<.001$), but not orangutans (n=34 sessions, NS). Gorilla participants initiated more affiliative behavior to conspecifics when research opportunities were unequal versus equal ($\chi^2(1)=11.64$, $p<.001$) and more aggressive behavior when opportunities were equal ($\chi^2(1)=8.66$, $p<.01$) suggesting they can identify and use behavior to mediate inequity while the more socially-independent orangutans did not. Supported by the David Bohnett Foundation.

Abstract # 120

AUDIENCE EFFECTS ON CHIMPANZEE DECISION-MAKING IN THE PRIMATE GAMBLING TASK

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There is debate about whether nonhuman species are sensitive to third-party image scoring or reputation building. In humans, audience effects during gambling, result in differential risk-taking. Here, we use chimpanzees (*Pan troglodytes*) to explore the influence of audience rank in a gambling task. Chimpanzees (1 male; 4 females) were presented with a computerized PGT where a close-up video of another chimpanzee's face (the alpha female or lowest-ranking female) or a nonsocial video was displayed during the task. The chimpanzees chose between two symbols, one represented a small, consistent reward and the other represented a more variable payout including zero outcomes. A repeated measures ANOVA indicated there was a significant difference between conditions [$F(2) = 4.913$, $p = 0.041$, partial $\eta^2 = 0.551$]. Post-hoc contrasts indicated that the mean percentage of choices for the high-variability payout structure was significantly different between the high-ranking ($M = 43.20$, $SD = 4.87$) and low-ranking ($M = 55.80$, $SD = 7.40$) conditions ($F(1) = 18.547$, $p = 0.013$, partial $\eta^2 = 0.823$). The nonsocial condition ($M = 50.60$, $SD = 6.19$) was not significantly different than either of the other conditions. Thus, chimpanzees vary their risk-taking based on their relative status compared to their audience. It is unclear if this is because they want to make an impression on low-ranking individuals or fear repercussions in the presence of dominants.

Abstract # 121

TOOL USE BY YOUNG ADULT BEARDED CAPUCHIN MONKEYS (*SAPAJUS LIBIDINOSUS*): DOES AGE OR BODY MASS PREDICT PROFICIENCY?

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Bearded capuchin monkeys at Fazenda Boa Vista, Brazil, begin to crack whole piaçava palm nuts using stone hammers after they reach about 1.5 kg body mass. The monkeys gain body mass until 8 - 10 years old, with females averaging 2.1 kg and males 3.5 kg. Does age or body size predict success or efficiency at cracking nuts? We videotaped five monkeys (4.3 - 8.4 years old; 3 females; body mass 1.7 - 2.5 kg) as we provided them with 14-35 piaçava nuts per individual. We coded actions with each nut, and the outcome. Monkeys attempted to crack 96 nuts (range: 14-27). Four capuchins cracked the nut on > 75% of their attempts, using 11 strikes per nut on average (range 5.3 - 17.6), overlapping the range of older adults studied previously. The fifth capuchin never cracked a nut, although she attempted to do so. This monkey sniffed and tapped nuts at higher rates than the others ($p<.001$ and 0.018, respectively), indicating continued interest. Body mass and age were modestly negatively correlated with percentage of nuts cracked and average number of strikes to crack a nut ($r_s = -.32$ to $-.40$, $N = 4$ or 5, NS). We conclude that proficiency does not parallel age nor body mass, and individual timelines to develop cracking vary widely. Permission by IBAMA #28689 and by CNPq/MCT #0002547/2011.

Abstract # 122

CHIMPANZEES AND BONOBOS DEMONSTRATE OROFACIAL-MOTOR AND BREATH CONTROL

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Human spoken language requires the concomitant utilization of numerous cognitive and motor skills. Two particularly relevant skills are orofacial-motor control (the ability to purposefully move ones' facial muscles; hereafter known as OFM), and breath control (subglottal air pressure that fuels sound production; hereafter known as BC). Many have claimed these competencies are uniquely human qualities, without great ape antecedents. However, here we describe both skills in our closest extant relatives: chimpanzees (*Pan troglodytes*) and bonobos (*Pan paniscus*). We hypothesized that OFM and BC would be present in both species of *Pan*, and bonobos would demonstrate increased OFM and BC due to their stronger reliance on vocal communication compared to chimpanzees. To test this hypothesis, forty apes (20 chimpanzees) were

trained to protrude their lower lip and tongue, inhale to retrieve a food item, and exhale to elevate a ball to a certain height in a clear cylinder. Apes underwent 50 OFM trials per condition, and the number of times the requested action was completed successfully was recorded. For BC, apes underwent 40 trials per condition, and success was recorded. If bonobos were to have increased OFM and BC, we predicted that they would successfully perform these tasks significantly more than chimpanzees. Preliminary data were analyzed using independent samples t-tests and indicate there are no species differences in OFM and BC (p=0.09).

Abstract # 124

WESTERN AND MEDITERRANEAN DIET EFFECTS ON WEIGHT GAIN, CARBOHYDRATE METABOLISM AND CSF MARKERS OF BRAIN HEALTH IN FEMALE CYNOMOLGUS MACAQUES (*MACACA FASCICULARIS*)

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Western (WEST) diet is associated with increased, whereas Mediterranean diet (MED) is associated with decreased risk of chronic diseases, Alzheimer's disease (AD) and vascular cognitive impairment. However, these associations are from population-based studies that may be confounded, or from rodent studies with limited translational relevance. Here we report effects of WEST versus MED diet on body mass index (BMI), the insulin response (IR) to a glucose tolerance test (GTT), and cerebrospinal fluid (CSF) biomarkers of AD risk: amyloid (A)-beta40 and 42, total tau, tau phosphorylated at threonine 181 (tau-p181), and the ratio tau-p181:Abeta42, a sensitive predictor of AD risk in humans. 40 socially housed middle-aged macaques consumed monkey chow for 8 months and BMI, ivGTT-IR, and CSF biomarkers were measured. The monkeys were randomized to WEST or MED for 2 years and measures were repeated. Mixed models ANOVA revealed an increase in those consuming WEST but not MED in BMI (diet X treatment phase p=0.001) and IR (diet X treatment phase p=0.03); lower Abeta40 levels in the MED group (p<.04), and a diet X time X age interaction (p<0.04) for tau-P181:Abeta42. Among older animals, WEST had increased whereas MED had decreased tau-P181:Abeta42. These results suggest that MED diet may preserve vascular integrity (decreased Abeta40), and WEST diet may increase AD risk (increased tau-P181:Abeta42). These changes may be mediated by peripheral hyperinsulinemia due to increased adiposity.

Abstract # 125

MATERNAL AND EPIGENETIC PROGRAMMING OF INFLAMMATION

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Early life experiences are formative, and make lifelong contributions to health. We have previously observed that poor quality maternal care, or low maternal sensitivity (MS) enhances inflammation, a risk factor for cardiovascular and metabolic disease, at a very early developmental stage in rhesus macaques. We characterized the potential epigenomic factors involved with this relationship in 44 infant rhesus macaques. Whole genome DNA methylation patterns were quantified from whole blood DNA using restricted representation bisulfite sequencing (RRBS). Bioinformatics analysis shows that over 13.6% of covered CpG sites (1252/9203 that meet QC standards, at least 10X coverage) are significantly differentially methylated based on MS and inflammatory status (high vs. low; q-value < .0001). A significant number of these differences were shared by low MS infants and infants exhibiting high inflammation (Fisher's Exact test = 20.4, p = 2.49E-254). Gene ontology analysis shows that while MS-Inflammation DMRs affect multiple pathways, genes in the adrenergic and inflammatory pathways were enriched. In enriched pathway genes, functional analysis suggests that methylation ratios in low MS infants are likely to promote inflammation and ADR insensitivity, especially pertaining to B-AR signaling, relative to high MS infants. Taken together, these data suggest that low MS may predicted higher inflammation in infants by reducing immune cell sensitivity to sympathetic innervation and enhancing inflammatory signaling.

Abstract # 126

TREATMENT OF CHRONIC IDEOPATHIC DIARRHEA IN A PIGTAILED MACAQUE (*MACACA NEMESTRINA*) WITH FLUOXETINE

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An 11 y/o male pigtailed macaque with a normal rearing history and housed in a harem at the Johns Hopkins University breeding farm present with a history of chronic, idiopathic diarrhea and chronic, idiopathic diarrhea, both refractory to multimodal treatment. He was noted to have a milieu of behaviors that have elsewhere been described as being associated with serotonin dysfunction, and this guided our decision to attempt treatment with fluoxetine, a selective serotonin reuptake inhibitor, at a dose of 2 mg/kg by mouth once daily. In 178 days prior to initiating fluoxetine treatment, the animal's fecal score averaged 3.12 (out of 4). In the 35 days following treatment, his average fecal score fell to 2.74. Furthermore, the 35-day average fecal score fell by 0.8 point during this time, and was lower than all but 12 of 144 such periods prior to beginning treatment. This result suggests that behavioral evaluation of animals with idiopathic diarrhea may yield information suggesting a psychological etiology, and thus guide appropriately targeted therapy.

Abstract # 127

TREATMENT OF IDEOPATHIC ANOREXIA IN COMMON MARMOSETS (*CALLITHRIX JACCHUS*) WITH MIDAZOLAM

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Two adult female common marmosets at Johns Hopkins University presented for chronic anorexia following stressful events. One animal refused to eat following social separation from her mother and then her human handler. The animal weighed 280g when we initiated therapy with midazolam, a short-acting benzodiazepine anxiolytic, given in conjunction with twice daily meal times. After dose titration with minimal voluntary food consumption, on d8 a dose of 0.2 mg/kg was administered intramuscularly, at which time the animal consumed all of her 30g food ration. Using this same dose over the next 20 days, the animal consumed >75% of her ration for all but two meals when given midazolam, still refusing to eat when offered food without midazolam treatment. Over this time her body weight increased to 318g, and we observed that the delay between injection and first consumption of food had decreased. This prompted us on d20 to attempt therapy with saline only, after which the animal readily consumed her total ration. This result was repeated with the same result, which we attribute to a learned association (via classical conditioning) between the injection procedure and increased appetite. It remains unclear whether this effect on anorexia is due to anxiolysis or direct appetite stimulation, but we have produced and will present similar results using oral midazolam in this same and a second animal.

Abstract # 128

COCHLEAR SYNAPTOPATHY IN THE NOISE-EXPOSED AND AGING RHESUS MACAQUE (*MACACA MULATTA*)

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The audiogram has long been regarded as the gold-standard test of hearing ability. However, recent rodent research has demonstrated that noise exposures causing only temporary threshold shifts can induce a permanent loss of ~50% of synapses on inner hair cells (IHCs) that is undetectable by audiograms. This is because the 'cochlear amplifier' (outer hair cells; OHCs) and the low-threshold auditory nerve fibers (ANFs) are spared. Synaptopathy is selective for the normally high-threshold ANFs that are crucial for signal-detection in noise. This likely degrades speech-in-noise performance despite normal audiograms, is referred to as 'hidden hearing loss.' When OHCs are also damaged, both threshold and suprathreshold

performance are compromised. To assess the generality of these findings to primates, we compared the normal cochlear innervation of young, unexposed macaques to that of noise-overexposed or aging animals. Cochlear function was assayed for 8-wks. Following 108-dB SPL noise, monkeys with normal audiograms had 15-30% synaptopathy. Following 146-dB SPL noise, 50-80% synaptopathy was accompanied by widespread OHC loss, threshold shifts, and suprathreshold deficits. Aging, unexposed monkeys had varying degrees of synaptopathy with little HC loss. These data indicate that primates are susceptible to noise-induced and age-related synaptopathy. In the future, we will use macaques as a model for developing diagnostics and testing emerging therapies for cochlear synaptopathy.

Abstract # 129

A VALIDATION STUDY OF HAIR CORTISOL IN RHESUS MONKEYS

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Analysis of cortisol in hair has become a widespread tool for assessment of hypothalamic-pituitary-adrenal (HPA) axis activity because of its ease of collection and its ability to provide longitudinal data. In order to meaningfully interpret hair cortisol a radio-metabolism study is required to understand hormone incorporation into hair. Tritiated (3H)-cortisol was administered to 4 adult rhesus monkeys (*Macaca mulatta*) to determine quantity and form of cortisol in hair. Samples of hair were collected from new and previously shaved patches at 2-weeks and 4-weeks. Hair was processed by external wash, grinding, and hormonal extractions. Samples were separated by high-performance liquid chromatography (HPLC) and fractions were collected and radioactivity assessed. Only 1-4 % of the total radioactivity was incorporated into the hair and this was found by the 2-week hair collection. No further radioactivity was found by the 4-week collection. The quantity of hair collected at the 2 and 4-week collections was highly variable between monkeys, indicating that the between-subject hair growth patterns were not consistent. Importantly, for the first time, we showed that centrally administered 3H-cortisol was found in the hair as 3H-cortisol and 3H-cortisone, as well as other glucocorticoid metabolites, which demonstrated that measurement of hair cortisol is representative of circulating cortisol, but may not be the only important measure. Funding sources: NIH P51OD011106, WNPRC Pilot Funding.

Abstract # 130

PREDICTORS OF PARASITE RISK IN MALE SAVANNA BABOONS (*PAPIO CYNOCEPHALUS*)

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Among male primates, social status is an important predictor of disease risk and parasitism. To date, general frameworks to explain patterns of status-related variation in parasitism have remained elusive. Because heterogeneities in parasite infection are driven not only by differences in host physical condition, but also by patterns of parasite exposure, whether high or low status predicts infectious disease risk, remains an open question. We tested rank-related, and other social and ecological predictors of parasitism in male baboons (*Papio cynocephalus*) living in the Amboseli baboon population in Kenya. We collected behavioral, demographic, ecological, and physiological data over a five year period, and analyzed 634 parasitological samples from 85 individual males. Linear mixed models [alpha<0.05] revealed that low-ranking males exhibited significantly higher parasite richness and whipworm (*Trichuris trichuria*) intensities than high-ranking males, and that patterns of exposure were modulated by rainfall, temperature, and sex ratio. Collectively, we found that male parasite risk is predicted by both inter-individual susceptibility to parasite risk and by patterns of exposure mediated by differences in social status. We discuss these results in the context of the evolution of host-parasite interactions, and we provide an explanation of why rank-related patterns of parasitism might differ from other measures of health.

Abstract # 131

ASSOCIATIONS OF INFLAMMATORY MARKERS WITH SEX, AGE, AND CORTISOL IN ZOO-HOUSED WESTERN LOWLAND GORILLAS (*GORILLA GORILLA GORILLA*)

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Sex, age, and stress may affect inflammatory markers, such as albumin, C-reactive protein (CRP), interleukin-6 (IL-6), and tumor necrosis factor alpha (TNF-a). This research explored whether sex, age, and cortisol are associated with inflammatory markers in western lowland gorillas. Biomarkers were assayed from banked gorilla serum (n=63, aged 6-52 years) from three North American zoos. Relationships between inflammatory markers and sex were tested using t-tests, and relationships with age and cortisol were tested using linear regressions (α=0.05). Males had higher albumin than females (p=0.001). Albumin was negatively associated with age (p=0.000, R^2=0.195) and cortisol (p=0.024, R^2=0.073). Females had higher CRP than males (p=0.000). CRP showed no relationship with age (p=0.874), but a positive association with cortisol (p=0.000, R^2=0.236). IL-6 showed no significant difference between males and females (p=0.956). In addition, IL-6 was positively associated with age (p=0.001, R2=0.195), but was not associated with cortisol (p=0.729). When outliers were excluded, females had significantly higher TNF-α than males (p=0.037), although this relationship was absent when outliers were retained (p=0.145). TNF-α was not significantly associated with age (p=0.440), but was positively associated with cortisol (p=0.000, R^2=0.432). As persistent elevations in inflammatory markers are associated with chronic degenerative conditions (e.g., cardiovascular disease, arthritis) and many zoo-housed great apes develop such conditions, understanding how sex, age, and stress affect their serum concentrations may aid in improving primate health and welfare.

Abstract # 133

ANXIETY AS A MEDIATOR OF ALCOHOL INTAKE IN LABORATORY-LIVING RHESUS MACAQUES (*MACACA MULATTA*)

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Studies show that the earlier teens take their first drink, the more likely they are to become dependent later in life. Because the origins of alcoholism often occur before the legal drinking age, investigating factors that lead to teenage alcohol use is an important step in the prevention of alcoholism. Studies show that anxious adolescent rhesus monkeys consume alcohol at levels that produce intoxication. As anxiety is a relatively stable temperamental trait over time, it is hypothesized that anxiety in adolescence will be associated with high alcohol intake. In the present study, 12 male rhesus macaques were tested in the Human Intruder Paradigm, a widely-used, standardized method of analyzing anxiety in the presence of an ecologically meaningful threat. One month later, subjects were allowed to freely consume an 8.4% alcohol/aspartame sweetened solution (v/v) for two hours each day, five days a week over a period of nine weeks. A One-Way ANOVA showed a significant main effect of anxiety [F(1,12)=7.03; p=0.023], with subjects characterized as highly-anxious consuming more alcohol (M=0.34±0.04 g/kg) than subjects characterized as having low anxiety (M=0.17±0.05 g/kg). Our results suggest that anxiety is associated with high alcohol intake among adolescent populations, a finding that may contribute to our ability to accurately predict susceptibility to excessive alcohol consumption and offer insights into the development of alcohol use disorders.

Abstract # 140

RHESUS MONKEY (*MACACA MULATTA*) GROUPS WITH MORE NON-NATAL ADULT MALES PER ADULT FEMALE HAVE LOWER RATES OF AGGRESSION-INDUCED TRAUMA AND GREATER REPRODUCTIVE SUCCESS

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Limiting contact aggression and social stress is a principal animal welfare challenge in managing large groups of captive nonhuman primates. This challenge is especially pronounced in rhesus monkeys (*macaca mulatta*), a species characterized by a relatively high frequency of aggression in captivity. Recent behavioral studies have found that adult non-natal male macaques play a pro-social role in mitigating aggression between females through impartial conflict interventions (i.e. "policing"). Relatively low adult male:female ratios (M:F) may negatively impact effective policing; however, there is limited research linking M:F to long-term clinical and reproductive outcomes. The current retrospective study examined demographic and clinical data from four large rhesus breeding groups over an 11-year span to examine M:F in relation to trauma rate and reproductive success. We hypothesized that groups with fewer females per male (range 1:34 to 1:8 males to females) would have lower rates of injury and increased reproductive output, perhaps due to the group stability benefits provided by adequate male policing. Controlling for group size and limiting our sample to years in which there were no matrilineal overthrows, we found a positive Pearson Product-moment correlation between M:F and reproductive success (r=.61,p=.003) and an inverse correlation between M:F and trauma (r= -.44, p=.045). These results underscore the importance of developing strategies to manage social groups such that M:Fs are optimal for group welfare and stability.

Abstract # 141

A COMPARISON OF ACTIVITY PATTERNS OF CAPTIVE CHIMPANZEES (*PAN TROGLODYTES*) HOUSED IN PRIMADOMES™ OR CORRALS

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Primadomes™ and corrals, two types of housing options available to captive chimpanzees, differ in several physical features, including closed (primadomes™) or open (corrals) tops, mesh (primadomes™) or concrete (corrals) walls, and available space per animal (142 ft^2/individual in primadomes™; 516 ft^2/individual in corrals). Our group has produced one preliminary study comparing differences in chimpanzee behavior across these two types of housing conditions; only social play differed significantly between chimpanzees housed in primadomes™ and corrals. Here, we observed the behavior of four chimpanzee groups: two groups housed in primadomes™ (n=14) and two groups housed in corrals (n=16). Focal animal observations were performed to examine social proximity, and affiliative, abnormal, locomotor, aggressive, sexual, species-typical, and solitary behaviors. On average, chimpanzees in primadomes™ spent significantly less time resting [9.6% primadomes™, 18% corrals, t(22.8)= -3.3, p=.003], and more time climbing [1.2% primadomes™, 0.06% corrals, t(15.6)=3.35, p=.004], foraging [1.5% primadomes™, 0.04% corrals, t(14.64)=2.1, p=.055], and using enrichment [2.2% primadomes™, 0.6% corrals, t(16.97)=2.81, p=.012] than did corral-housed chimpanzees. There was also a trend toward more time spent alert, but inactive, in primadomes™ [41% primadomes™, 34% corrals, t(28)=1.81, p=.08]. Time spent in all other behaviors, including aggressive, affiliative, and abnormal (behaviors indicative of well-being) did not differ significantly between chimpanzees in primadomes™ and corrals. Overall, these activity patterns suggest that chimpanzees in both housing conditions experience comparable well-being.

Abstract # 142

ENRICHMENT USE & SOCIAL INTERACTIONS IN A MIXED-SPECIES ENCLOSURE OF SUMATRAN (*PONGO ABELII*) & BORNEAN ORANGUTANS (*P. PYGMAEUS*) & NORTHERN WHITE-CHEEKED GIBBONS (*NOMASCUS LEUCOGENYS*) AT THE OREGON ZOO

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Captive settings use enrichment to provide mental and physical stimulation and elicit species-specific behaviors through natural and artificial objects placed in the enclosure. One example is mixed-species exhibits. In this study, EV observed enrichment use and social interactions in a mixed-species enclosure at the Oregon Zoo, which housed Sumatran and Bornean orangutans, alternately, with Northern white-cheeked gibbons (n = 6). EV conducted 15-minute focal samples from August - September 2015, totaling 180 observation hours. One prediction was that subjects would be more likely to use arboreal enrichment over terrestrial. Using chi-square tests, EV tested whether each ape was equally likely to use arboreal or terrestrial enrichment. We found all individuals were more likely to use arboreal over terrestrial enrichment ($p<0.05$ for all individuals). All subjects were also predicted to interact with their conspecifics over heterospecifics. Both orangutans (O1: $X^2 = 126.84$, DF = 2, $p<0.05$; O2: $X^2 = 197.86$, DF = 2, $p<0.05$) interacted with one another over the gibbons, as did both gibbons (G1: $X^2 = 92.43$, DF = 2, $p<0.05$; G2: $X^2 = 139.69$, DF = 2, $p<0.05$). Rates of aggression in the enclosure were low (n = 17 occurrences/180 hours). Results indicate gradual reduction of terrestrial enrichment and increased appeal of arboreal enrichment encourages arboreality for all apes. Additionally, as subjects become more comfortable in enclosure, rates of social interactions with heterospecifics might increase.

Abstract # 143

PREDICTORS OF PAIR HOUSING SUCCESS VARY IN CAPTIVE ST. KITTS AFRICAN GREEN MONKEYS (*CHLOROCEBUS SABAEUS*) VERSUS CAPTIVE TANZANIAN AFRICAN GREEN MONKEYS (*CHLOROCEBUS PYGERYTHRUS*)

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Though African Green Monkeys (AGMs), or vervets, are widely used in research, little is known in regards to their successful pair housing. Due to difficulties with long-term successful social housing of same-sex pairs, we attempted to form mixed-sex pairs with vasectomized St. Kitts AGMs (*Chlorocebus sabaeus*) and mixed-sex pairs of reproductively intact Tanzanian AGMs (*Chlorocebus pygerythrus*). To assess whether predictors of successful pair housing vary in St. Kitts versus Tanzanian AGMs, we collected focal data on 10 pairs of St. Kitts AGMs and 22 pairs of Tanzanian AGMs (September 2009- November 2016). We found that initial approaches in successful socializations are by females in St. Kitts AGMs, and by males in Tanzanian AGMs (Fisher's Exact Test, $p <0.0001$). In initial stages of socialization, St. Kitts AGMs spent significantly less time in physical proximity to their social partners than Tanzanian AGMs (Mann-Whitney test: U = 112.0, nSt. Kitts = 7, nTanzanian = 16, p = 0.002). Qualitatively, we found that any noted mounting behavior in St. Kitts AGMs resulted in unsuccessful pairs; while there was no difference in number of mounts in successful versus unsuccessful Tanzanian AGM pairs (Mann-Whitney test: U=59.500, nsuccessful = 10, nunsuccessful = 6, p= 0.3621). These results suggest that certain species specific behaviors may help determine pair housing success in various *Chlorocebus* species perhaps leading to more widespread social housing of *Chlorocebus*.

Abstract # 144

RESPONSE SPEED ON A SIMPLE TOUCHSCREEN TASK AS A WELFARE INDICATOR: A STUDY OF ZOO-HOUSED JAPANESE MACAQUES

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Judgement-bias tasks designed to measure mood in animals have gained attention as a potential promising welfare measure, yet they typically require extensive training. Therefore, simpler analogues are required. At Lincoln Park Zoo in Chicago, we tested four Japanese macaques (*Macaca fuscata*) who previously failed to meet training criteria on a traditional judgement-bias task with a simplified 'response slowing' paradigm. This paradigm relied on latencies to touch potentially threatening (conspecific face with directed gaze) and non-threatening (conspecific face with averted gaze) images, relative to control images (grey squares) presented on a touchscreen. Participation was voluntary and took place in touchscreen booths integrated into their zoo habitat. Monkeys were tested in two conditions: during a baseline (non-stressful) period and during three days of a putatively stressful public event during which loud jets frequently flew overhead. Results indicated a significant effect of condition, with an increase in latency to touch images of conspecific faces relative to control images during the stressful time period (GLMM full-null model comparison, $\chi^2 = 16.86$, $p < 0.001$). These findings suggest that emotional states may be revealed through response latencies in a simple touchscreen task that does not involve extensive training.

Abstract # 145

WELFARE MEASURES FOR LABORATORY CHIMPANZEES IN THE UNITED STATES

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Behavioral assessment is an essential element of chimpanzee care. Behavioral data were compiled from four chimpanzee laboratory facilities (N=522; 286 females, 236 males) using differing methods of assessment including quantitative data collection, animal records and observations by behavioral management staff. The subjects were 46.4% mother-reared (MR), 46.9% non-mother-reared (NONMR), and 6.7% wild-born (WB). Mean group size was 5.9, 100% had access to outdoor space all year, and 59.2% had daily access to natural substrate. Species-typical behaviors were surveyed: 95.4% used tools to acquire food; 50% built nests; 94.4% initiated grooming; and 68% copulated. Forty-two percent showed abnormal behavior; most commonly stereotypic rocking and coprophagy. Ninety-seven percent generally voluntarily cooperate with requests to shift and 64.2% present for an injection. Chi-square analyses (df = 2) revealed MR chimpanzees were more likely than NONMR to use tools (Chi-square = 16.73, $p < .001$) and to initiate grooming (Chi-square = 22.59, $p < .001$). WB were more likely to build nests than MR and MR more likely than NONMR (Chi-square = 82.25, $p < .001$). MR and WB were more likely than NONMR to copulate (Chi-square = 30.43, $p < .001$). MR were more likely than NONMR to display coprophagy (Chi-square = 11.74, $p = .003$). This analysis will help guide future improvements in behavioral management to address existing behavioral problems or deficits.

Abstract # 146

MACROENVIRONMENTAL EFFECTS ON THE WELL-BEING OF SINGLY-CAGED MALE RHESUS MACAQUES (*MACACA MULATTA*)

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Determining the effects of the macroenvironment on the welfare of nonhuman primates can help identify their needs and guide their behavioral management. We evaluated the behavior of 37 adult male rhesus macaques in two housing settings at the Tulane National Primate Research Center. While caging and enrichment were identical, the two settings varied in the level of disruption in the macroenvironment. Individuals housed in the high-disruption location were exposed to more frequent potentially stressful human activity and as well as visual and auditory exposure to a larger and more rapidly shifting population of animals. Behavioral data (240 h) were collected using instantaneous focal animal sampling. Multivariate analysis of variance was used to test the effects of condition, with temperament and age as covariates. Only main effects of condition were found. Individuals in the high-disruption condition showed lower levels of observer-directed

aggression (p=.008), a trend toward less anxiety-related behavior (p=.078), and higher levels of vigilance (p=.012). Levels of abnormal behavior, alarm calling, and aggressive displays did not vary. These findings do not support the notion that frequent potentially stressful activity and low levels of stability inevitably result in chronic stress. Furthermore, the lack of correspondence between patterns of vigilance and indicators of reduced well-being suggest an unclear relationship between focused environmental scanning and anxiety, fear, and distress.

Abstract # 148

AMOUNT AND RECIPROCITY OF AFFILIATIVE BEHAVIORS CAN PREDICT PAIRING SUCCESS IN CAPTIVE RHESUS MACAQUES (*MACACA MULATTA*)

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Socialization is one of the most important forms of enrichment for rhesus macaques. However, pair introductions can result in aggression and injury if partners are incompatible, even days after the initial introduction. Identifying predictors of long-term compatibility early on can reduce potential stress and injury to animals. We analyzed data from ten-minute focal observations during the first day of 641 female-female and 472 male-male rhesus macaque introductions to identify predictors of pairing success (i.e., co-housed in full contact without inappropriate aggression or fear for over 14 days). 73% of female-female pairs and 74% of male-male pairs were successful. Behaviors coded included grooming, rump presents, mounting, and tandem threats (cooperative threat to another individual) and were recorded as present/absent for each animal during 30 20-second intervals. We found that both the total amount of affiliation and the amount of affiliation reciprocated between partners predicted success. Successful female pairs showed more tandem threats ($t=9.3$, $p<0.001$), grooming ($t=3.5$, $p<0.001$), and reciprocal grooming ($t=2.3$, $p=0.02$) than unsuccessful pairs. Successful male pairs showed more tandem threats ($t=5.7$, $p<0.001$), grooming ($t=4.8$, $p<0.001$), mounting ($t=6.8$, $p<0.001$), reciprocal mounting ($t=4.7$, $p<0.001$), and reciprocal rump presents ($t=2.6$, $p=0.01$) than unsuccessful pairs. Although the specific behaviors differed for males and females, these results show that the amount of affiliation and the reciprocation of particular behaviors early in the introduction process can predict pair compatibility.

Abstract # 149

TRAUMA AND MALE TENURE IN SPF RHESUS MACAQUE (*MACACA MULATTA*) BREEDING GROUPS

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YNPRC introduces breeder males to the SPF rhesus colonies every three years to increase genetic variability, avoid inbreeding and decrease the sex ratio with the goal of moderating aggression within the group. Eleven multi-generational breeding groups, comprised of adults, juveniles and infants (N=20-150 individuals), were examined to determine if introduction of males had an effect on aggression and trauma levels within the group. Trauma data spanning the breeding season were collected. Instances of trauma were analyzed corresponding to the final year of male residence (year three in the rotation) for the established breeder male(s), introductory year and second year of residence for new males. While repeated measures analyses indicated a significant difference in levels of trauma between the 11 groups ($F=25.8[1,10]$, $p=0.000$), likely attributed to the differences in group sizes, more noteworthy was the significant difference across the three years within the social groups ($F[2,20]=10.1$, $p=0.001$) which was seen in all groups. Overall mean trauma levels were identical in the final year of residence for the established male(s) and the second year for the new male(s) ($X^2=26.545$); however, the mean number of trauma occurrences was almost twice as great as the introductory year ($X^2=47.727$). These findings suggest that trauma increases with the introduction of new males to a breeding group. Over time, these levels decrease supporting that male social integration is critical to social stability.

Abstract # 151

REMOVALS BASED ON LOW WITHIN-MATRILINE RELATEDNESS CAN REDUCE SEVERE AGGRESSION IN CAPTIVE RHESUS MACAQUES

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Previous observational research of captive rhesus macaques suggests that higher coefficients of relatedness within matrilines are associated with lower rates of severe within-matriline aggression and more cohesive grooming communities. We tested whether experimental removals targeted to increase the relatedness coefficient of remaining matriline members leads to fewer grooming communities and a lower ratio of severe aggression within matrilines. The study sample was comprised of 100 adult females within 13 matrilines in 1 mixed-age-sex group. The Girvan-Newman method was used to detect communities and modularity (score Q) within matrilines. We used generalized linear regression models to determine the best model predicting the ratio of severe within-matriline aggression. Seven matrilines received experienced removals and results show fewer grooming communities in those matrilines (Beta=-1.33, p=0.04), but not a reduction in modularity (Beta=0.04, p=0.99). The coefficient of relatedness was negatively correlated with number of grooming communities (rho=-0.52, p<0.001) and modularity (rho=-0.58, p<0.001), so these had to be tested separately rather than in one model. The number of grooming communities (Beta=0.11, p=0.03) within matrilines was a better predictor of the ratio of severe aggression than coefficient of relatedness (Beta=0.72; p=0.36) or modularity (Beta=-0.14, p=0.82). These results show that the coefficient of relatedness can be a useful management tool to selectively remove individuals from captive rhesus macaque social groups as long as it results in fewer grooming communities within targeted matrilines.

Abstract # 152

CAMERA TRAP RECORDS OF TERRESTRIALITY IN FIVE PERUVIAN PRIMATE COMMUNITIES

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Most Neotropical primate species are highly arboreal, and documentation of terrestrial behavior is scarce. Most records are in the context of gap crossing, predator avoidance, foraging/consumption of specific resources (e.g. water, clay at salt licks), or social interaction (e.g. females escaping attack). Nevertheless, monkey groups must be well-habituated to engage in such behaviors in the presence of human observers, making camera trapping a useful tool for its documentation. During terrestrial mammal studies in five protected areas in Amazonian Peru (Manu National Park, Amarakaeri and Sira Communal Reserves, Purus Conservation Concession, Maijuna-Kichwa Regional Conservation Area) using large camera networks, we documented 94 events (22% with >1 individual) of five primate species (*Cebus albifrons*: N=50, *Saimiri boliviensis*: N=24, *Sapajus apella*: N=18, *Ateles chamek*: N=1, and *Lagothrix cana*: N=1) over 62,000 trap nights. While overall primate trapping rates are extremely low relative to other species (e.g. in Amarakaeri: primates = 0.071 events/100 trap nights; *Eira barbara* [semi-arboreal] = 0.82; *Dasyprocta variegata* [terrestrial] = 3.51), these data represent valuable documentations of an unusual behavior. Furthermore, provocations for terrestriality (e.g. salt licks, forest gaps) were absent in the study areas, suggesting that ground movement may be part of the behavioral repertoire of these species in intact forest. Being that camera trapping is a relatively non-invasive method, we suggest terrestrial studies may be useful sources of data on this rare behavior.

Abstract # 153

TIMING OF EARLY MORNING BEHAVIORS OF NEW WORLD PRIMATES AT THE TIPUTINI BIODIVERSITY STATION IN AMAZONIAN ECUADOR (*ALOUATTA*, *ATELES*, *CALLICEBUS*, *LAGOTHRIX*, *PITHECIA*)

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Diurnal arboreal primates begin their day with a sequence that typically includes defecation/urination, vocalizations, movement from the sleeping tree, and feeding. We compared timing of first occurrences of morning behaviors for five sympatric species. With rare exceptions, morning activities began only after the onset of nautical twilight (~48 min before sunrise). Vocalizations were tabulated up to 2.5 hours after sunrise. *Alouatta* and *Callicebus* made frequent loud calls; 75% of *Alouatta's* loud calls, and 45% of Callicebus' loud calls occurred between nautical twilight and sunrise. *Callicebus* waited much later to feed; median time for the first feeding bout was 1.5 hours after sunrise. Other taxa made mostly lower-volume contact calls--half to three-quarters after sunrise--typically associated with movement from the sleeping tree. All feeding bouts of *Callicebus* and *Pithecia*, 90% of *Lagothrix's*, and 80% of Ateles' occurred after sunrise. Comparisons among species were analyzed using lm models. Median feeding times of *Ateles* were 35 min earlier than others ($p<0.05$ vs *Callicebus* and *Lagothrix*; $p< 0.001$ vs *Pithecia*); *Lagothrix* and *Callicebus* were similar; and *Pithecia's* median was 21 min later than the rest ($p< 0.05$ vs *Callicebus*, $p< 0.01$ vs *Lagothrix*). These behavioral differences occur during a period of large changes in ambient illumination, and differences in luminosity could have important influences on the diverse visual phenotypes of these New World primates.
Support: NSF IOS-0843354, BCS-1062540, BCS-1540403

Abstract # 154

TERRESTRIAL ACTIVITY IN TWO SPECIES OF SQUIRREL MONKEYS (*SAIMIRI COLLINSI* AND *SAIMIRI CASSIQUIARENSIS*) LIVING IN DISTINCT AMAZONIAN ECOSYSTEMS

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Squirrel monkeys are primarily arboreal quadrupeds, although they have been found to prefer the understory at several study sites. In order to investigate the frequency of terrestriality in *Saimiri* and the socio-ecological contexts in which it occurs, we analyzed focal, scan and all-occurrence data from two species of squirrel monkeys (*S. collinsi* and *S. cassiquiarensis*), inhabiting two different Amazonian ecosystems (high-ground terra firme rainforest and seasonally inundated, várzea rainforest, both in Brazil). In addition to between-site comparisons, we analyzed ground use data according to age of the individuals, season and activity. Results from both species and both sites indicated that squirrel monkeys primarily come to the ground for foraging activities (85.5% of observations), rarely using the ground for crossing open areas. Both adult and juvenile *Saimiri collinsi* used the ground mostly to procure insect prey, *Attalea maripa* (Arecaceae) fruit and *Strypnodendron pulcherrimum* (Leguminosae) fruit, and more so in the dry season. *S. cassiquiarensis* used the forest floor more frequently than *S. collinsi* (2.5 events/hour vs. 0.27 events/hour), particularly to forage for arthropods and *Caperonia castaneifolia* (Euphobriaceae) flowers, and adults were more terrestrial than juveniles (2.06 events/hour and 0.47 events/hour, respectively; Fisher's exact test; $p<0.0001$). Although terrestrial behavior in squirrel monkey is not performed without safety costs, it also provides access to an important foraging substrate, especially during periods of low fruit availability.

Abstract # 155

GPS-IDENTIFIED LOW-LEVEL NOCTURNAL ACTIVITY OF VERVETS (*CHLOROCEBUS PYGERYTHRUS*) AND OLIVE BABOONS (*PAPIO ANUBIS*) IN KENYA

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All anthropoid primates are considered strictly diurnal except for owl monkeys (*Aotus*). New technology has shown, however, that some anthropoids also engage in nocturnal activity. Here we examine the extent to which vervets (*Chlorocebus pygerythrus*) and olive baboons (*Papio anubis*) are active at night. We deployed GPS collars with tri-axial accelerometers on 12 vervets in five groups and six olive baboons in four groups. For seven months their locations were recorded every 15 min, and their activity levels, for 3 sec every min. We also employed remote cameras aimed at terrestrial movement at seven sleeping sites. Travel was detected on 0.4% of 2029 vervet-nights involving three vervets and 1.1% of 1109 baboon-nights involving five baboons. Since no monkeys were photographed on the ground at night, nighttime travel was likely arboreal. Baboons traveled on significantly more nights than vervets ($\chi^2 = 4.33$, $p = 0.04$). During the night, vervets were active 13% of the time, and baboons, 15%. Activity varied little throughout the night and was unaffected by moon phase. We suggest that their low nocturnal activity may be related to living near the equator with consistent 12-hr days, in contrast to anthropoids that are more nocturnally active. Since anthropoids are thought to have evolved in northern latitudes, with later dispersal to tropical latitudes, our results may have implications for understanding the evolution of anthropoid diurnality.

Abstract # 156

DO SANCTUARY CHIMPANZEES (*PAN TROGLODYTES*) BEHAVE DIFFERENTLY WHEN UNFAMILIAR PEOPLE ARE PRESENT?

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Sanctuaries are typically closed to the public, but at times resident animals may be exposed to unfamiliar visitors (e.g. during donor tours or education programs). While zoos report mixed findings regarding effects of visitors on chimpanzee behavior, effects in sanctuaries remain largely unexplored. Such information can help sanctuaries weigh potential benefits and challenges of public programs. We observed four groups of adult chimpanzees (N=50, 23 females) housed at Chimp Haven for 110 hours over one year. Observations occurred either with no visitors present or during regularly scheduled public programs. As chimpanzees were more likely to receive food when visitors were present (GLM, $F=25.953$, $p<0.001$), we investigated the relative influence of food provisioning and visitor presence on behavioral changes. In the presence of visitors, chimpanzees spent more time outdoors (in view of unfamiliar people) (GLM, $F=20.164$, $p<0.001$). In addition, chimpanzees increased time spent feeding (GLM, $F=13.904$, $p<0.001$) and moving (GLM, $F=5.784$, $p=0.018$). Receipt of food best explained outdoor enclosure usage and feeding behavior, while locomotion was best explained by presence of unfamiliar people. These results suggest that while sanctuary chimpanzees may behave differently when visitors are present, food provisioning during these times can confound this relationship. Sanctuaries should take care in interpreting changes in residents' behavior during public programs that could potentially be explained by indirect influences (e.g. provisioning of food and enrichment).

Abstract # 157

BEHAVIORAL AND PHYSIOLOGICAL REACTIONS TO THREATENING STIMULI IN FEMALE COMMON MARMOSETS (*CALLITHRIX JACCHUS*)

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Although all studies of personality examine behavior, fewer incorporate concomitant measures of neuroendocrine activity. The hypothalamic-pituitary-adrenal (HPA) axis is a key pathway modulating responses to stress in most mammals. As such, it is expected to influence individuals' responses to threatening stimuli. Here we exposed 17 captive common marmoset (*Callithrix jacchus*) females to a known stressor, a leather glove, to explore the relationship between urinary cortisol and personality traits. We first recorded whether individuals investigated the stimulus. We then used the proportions of time each animal spent moving about the enclosure and emitting alarm behaviors to calculate activity and agitation scores, respectively. We also explored correlations among investigation, activity, and alarm-like behavior and finally assessed HPA activity by measuring urinary cortisol across the stressor. We used linear regressions to examine relationships between behavior and physiology. Preliminary results reveal that behavior scores were poor predictors of cortisol concentrations in the urine (baseline: $F_{7,9} = 0.48$, $p = 0.82$; reactivity: $F_{7,9} = 1.58$, $p = 0.27$). We also did not detect significant correlations between behavioral categories, although activity and agitation tended to be negatively correlated ($r = -0.22$). These results suggest that female marmosets exhibit substantial variation in their behavioral and neuroendocrine responses to threatening stimuli. Future studies should replicate exposure-trials over time to account for this inter-individual variation in behavior and physiology.

Abstract # 158

THE FINDER'S ADVANTAGE DOES NOT TRUMP HIGH-RANK WHEN WILD VERVET MONKEYS (*CHLOROCEBUS PYGERYTHRUS*) COMPETE FOR SMALL, DISPERSED RESOURCES DURING A FORAGING EXPERIMENT AT LAKE NABUGABO, UGANDA

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While group-living provides benefits to primates, intragroup feeding competition is a major disadvantage. Among group members, high-ranking individuals can monopolize resources; however, subordinates may compensate by foraging at the front of groups, acting as producers, and gaining a finder's advantage, acquiring some resources before dominants arrive. We examined how arrival order and dominance affected food acquisition during competition in a multi-destination foraging experiment with wild vervets (*Chlorocebus pygerythrus*) at Lake Nabugabo, Uganda. The experimental array consisted of six platforms in a large Z-shape within the vervets home range. Platforms were baited equally on every trial, each with a single banana slice. In 91 trials with two competitors each, dominant individuals (paired t-test: N=91, T=5.1, P<0.0001) and first arriving individuals (paired t-test: N=91, T=3.49, P=0.0008) acquired more food rewards than their competitors. Dominance was more important than arriving first though since first arriving subordinates could not acquire more banana slices than their dominant competitors (paired t-test: N=56, T=0.89, P=0.377). In contrast, a previous experiment at this site with clumped resources showed that subordinates arriving first could obtain equal rewards as dominants. Here, the benefits of arriving first were reduced with an arrangement of small, dispersed food items. However, subordinates still gained a finder's advantage by arriving first because they did better relative to when they arrived second (Wilcoxon: N=9, W=43, P=0.01).

Abstract # 159

SNAKE RESPONSES OF HUMANS AND OTHER PRIMATES: UPDATE AND INTERPRETATION

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Interactions with snakes have provided insights into primate psychology and ethology. Results have generated hypotheses about human evolution. Observational and experimental research has revealed multiple components of snake responses that can be placed in developmental contexts. However, since pivotal work by L. Isbell, comparative study has been limited. This paper addresses hypotheses about primate perceptions and behavioral mechanisms in response to snakes. It is especially concerned with analyzing the components of those responses in terms of similarity among primates, including humans. Most importantly, inconsistencies in results are examined via systematic comparison and they are resolved or explained where possible. The size of snakes emerges as a key stimulus that has remained largely unexamined. Small snakes (like many models in experiments) produce mild responses. Snakes that are dangerous to primates in natural habitats, and therefore likely to produce strong reactions, are large (e.g. pythons and mambas). Recent findings regarding human snake responses have largely paralleled the research on primates. Comparative data indicate the following conclusions for primates, including humans: (1) multiple components in perceptual and attentional mechanisms, including shape, movement, coloration, and size; (2) multiple components in behavioral responses and underlying mechanisms, including fear, aggression, and curiosity; (3) variation among species in some aspects of perception and response; (4) similarity and probably homology in other aspects; (5) learned and developmental components in various responses, especially fear.

Abstract # 160

FLUCTUATING SOCIAL BEHAVIORS OF A CAPTIVE BREEDING BORNEAN ORANGUTAN BOTH BEFORE AND DURING PREGNANCY

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The Association of Zoos and Aquariums' Orangutan Species Survival Plan® aims to maintain 100 Bornean orangutans (*Pongo pygmaeus*) of underrepresented mitochondrial lineages. Because of the high required investment in breeding individuals of these lineages and what often manifests as a "mismatch" of compatible orangutan personalities, it is essential that zoos understand how best to manage sociality of potential mothers. To improve management and reproductive success of these animals, more observational research needs to be conducted from pre-gestation to through the infant's first year of dependency. The Smithsonian's National Zoo's two adult Bornean orangutans successfully bred and gave birth to a male offspring in September 2016. The breeding female was observed over a two-year period, from pre-pregnancy to birth of the offspring, to explore how her behaviors changed or modified over time given the social networks she had with the other orangutans. Results indicate that during the pre-pregnancy phase, the breeding female socialized more with two other females over the males ($p<0.05$), but also socialized more with the male who did not sire her offspring ($p<0.01$). During the pregnancy period, the pregnant female socialized more with primate keepers than any of the orangutans ($p<0.01$). These data, especially those relating to fluctuating relationships between the breeding female and males, may help guide socialization options for future pregnant captive orangutans to improve reproductive success.

Abstract # 161

GRAPPLING EXPLAINED: AN INTRIGUING SOCIAL INTERACTION IN SPIDER MONKEYS (*ATELES GEOFFROYI*)

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The term grappling has been used to describe two different social interactions of spider monkeys (*Ateles* spp.): a form of wrestling play (van Roosemalen & Klein, 1988) and a complex interaction involving elements of several behaviors including face touching, embracing, and genital touching (Eisenberg & Kuehn, 1966). Given this ambiguity, clarification is warranted for researchers to communicate effectively and better understand this intriguing, yet rare interaction. We aimed to document the patterns of the second type of grappling. We observed an individually recognized wild community of spider monkeys living in Punta Laguna

in the Otoch Ma'ax yetel Kooh protected area, Yucatan, Mexico. We recorded the occurrence of grappling *ad libitum* from January 16 until December 10, 2014. We observed 13 grappling events in which both participants were individually recognized during approximately 800 hrs of field observation time. We observed 12 cases between males from all age categories and one case between infant females. We will show videos to demonstrate the behavioral elements involved in grappling, including face greetings, face touching, body sniffing, mutual embraces, tail wrapping, straddling of the partner, and touching of the other's genital region. The exchange of behaviors was usually long lasting, averaging 16min 20s (range: 2 min – 37 min). Given the context of its occurrence, grappling appears to be a mechanism for relationship testing under uncertain circumstances.

Abstract # 162

SOCIAL BUFFERING AND CONTACT TRANSMISSION: NETWORK CONNECTIONS HAVE BENEFICIAL AND DETRIMENTAL EFFECTS ON SHIGELLA INFECTION RISK AMONG CAPTIVE RHESUS MACAQUES

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Group living in primates may impact the risk of pathogen acquisition in two ways. First, social connectedness makes individuals more susceptible to pathogens via contact-mediated transmission. Yet in strongly bonded societies, having close connections and strong social ties can also socially buffer individuals against susceptibility to pathogens. Using social network analyses, we assessed the potentially competing roles of contact-mediated transmission and social buffering on the risk of infection from an enteric bacterial pathogen (*Shigella flexneri*) among captive rhesus macaques (*Macaca mulatta*). Within two groups, we found that infection risk was lowest among individuals possessing more direct (grooming out-degree: B = -2.31, df = 195, p = 0.04) and indirect (grooming eigenvector: B = -2.76, df = 195, p = 0.02) network connections, suggesting social buffering. In a third group, we found that infection risk was highest among individuals that initiated more aggression (out-degree: B = 5.09, p = 0.01) and less so among huddlers (betweenness: B = 3.42, df = 97, p = 0.07). Our findings reveal that social connections may, via contact transmission or social buffering, increase or decrease individuals' susceptibility to pathogens, depending on factors such as living-condition, pathogen-specific transmission routes, and/or overall social context. Broadly, they extend the applicability of the social buffering hypothesis, beyond just stress- and immune-function-related benefits, to infectious disease resistance.

Abstract # 165

FOXP2 VARIATION IN WILD GREAT APE POPULATIONS OFFERS POTENTIAL INSIGHTS INTO VARIATION IN COMMUNICATION

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The gene coding for forkhead box protein P2 (*FOXP2*) is the first gene discovered to be associated with human language disorders and fine control language production. Its evolution is hypothesized as an important factor in the origins of human speech and language. The protein coding sequence is highly conserved across mammals, with some notable exceptions, particularly in echolocating bats. Humans differ in only two functional amino acid substitutions from chimpanzees, bonobos and gorillas, with an additional fixed substitution found in orangutans. However, no study to date has examined the degree of natural polymorphism in great apes. Here we analyzed DNA sequence data from 63 chimpanzees, 11 bonobos, 48 gorillas and 37 orangutans. Results confirm previously reported between-species differences in functional

coding sequence between humans and great apes. However, inspection of within-species coding sequence reveals length variation in chimpanzees in two polyglutamine tracts. Additionally, two nonsynonymous SNPs were found. In gorillas, a G/T SNP in exon 7 leads to an Alanine to Serine substitution. In orangutans, a C/A SNP in exon 16 leads to a Proline to Threonine substitution, and is likely functional. Genotype frequencies were in Hardy Weinberg equilibrium (X2=2.20, df=1, p=0.138). The latter SNP is found only in Sumatran orangutans and may be associated with reported orangutan population differences in vocal repertoire and peak frequency.

Abstract # 166

AN INTEGRATIVE APPROACH FOR EVALUATING RHESUS MACAQUE SOCIAL BEHAVIOR: WHOLE GENOME SEQUENCING REVEALS A NATURAL LOSS-OF-FUNCTION MUTATION IN THE NEURONAL SCAFFOLDING PROTEIN *GRIP1*

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Evidence suggests that individual variation in social behavior arises from a combination of genetic predispositions and individual experience, yet the underlying biological mechanisms remain poorly understood. To address this gap, we have sought to understand the genetic contributions to social behavior in a large, free-ranging population of rhesus macaques (*Macaca mulatta*) with a known pedigree and detailed behavioral phenotypes. We hypothesized that genetic variants underlying molecular differences in neuroreceptors may be associated with behavioral variation in this socially complex species. For example, glutamate receptor interacting protein 1 (*GRIP1*) helps to stabilize glutamate receptors at excitatory synapses, and studies of neuronal-specific loss-of-function mice resulted in increased rates of prosocial behavior. To this end, we generated whole genome sequences for 217 individuals and identified over nineteen million population-wide single nucleotide variants, including those that alter amino acid changes in neuromodulatory pathway genes, including dopamine receptors, oxytocin and vasopressin receptors, serotonin transporters, and the mu-1 opioid receptor. Of the 2,022 highest-impact variants, seventeen were predicted to affect candidate genes for autism spectrum disorders, per the online database, SFARI Gene. One such variant, with a population allele frequency of 0.16, was predicted to eliminate the start codon of *GRIP1*. We describe the social behavior among the seventeen heterozygous and eleven homozygous macaques with this variant, suggesting approaches for integrating natural loss-of-function mutations with long-term behavioral data.

Abstract # 167

MICROSATELLITES IN THE NON-CODING REGION OF ARGININE VASOPRESSIN RECEPTOR 1A GENE (AVPR1A) IMPACT RECIPROCAL SOCIO-COMMUNICATIVE BEHAVIOR IN CAPTIVE CHIMPANZEES, *PAN* TROGLODYTES

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Studying the similarities and differences in socio-communicative behavior between chimpanzees and bonobos is critical to increase our understanding of human evolution. Chimpanzees are polymorphic for a naturally occurring deletion of a microsatellite containing region 5' of AVPR1a, while bonobos, like humans, are not polymorphic for this deletion. It has been suggested that this polymorphism might explain some of the behavioral differences observed between the two *Pan* species. We used identical methodology to collect socio-communicative behavioral data on captive chimpanzees and bonobos. Observational data on social proximity, grooming rates, and other socio-communicative behaviors were used to compare sociality between chimpanzees and bonobos and determine if chimpanzees without the deletion are more similar in their socio-communicative behavior to bonobos than those chimpanzees with the deletion. We have previously reported that captive chimpanzees with the polymorphic deletion 5' of AVPR1a spend a greater percentage of time alone than those chimpanzees without the deletion, F(1,66)=5.612, p=0.021. Here, we compare a more

complete set of socio-communicative behavioral measures from captive bonobos and chimpanzees to address the hypothesis that modifications in the non-coding region of the AVPR1a gene contribute to differential behavioral phenotypes observed both within and between the two extant *Pan* species.

Abstract # 168

WHOLE EXOME SEQUENCING IDENTIFIES A *GABRA6* VARIANT THAT PREDICTS ALCOHOL RESPONSE AND CONSUMPTION IN RHESUS MACAQUES

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Genetic factors predicting behavioral style may also influence alcohol use in modern humans. Exploiting the phylogenetically close relationship between human and macaque we have used a human-based exon assay to sequence exomes of rhesus macaques, selected based on variation in temperament. Among the damaging non-synonymous SNPs identified was one in the *GABRA6* gene, a known candidate for alcohol response differences in humans and rodents. Using datasets archived at the NIHAC, we examined whether rhGABRA6 genotype predicted alcohol response and consumption. Nursery- and mother-reared macaques were administered ethanol (2g/kg, IV), placed in a padded testing room and scored for their intoxication ratings. Animals were later given access to an 8.4% aspartame-sweetened alcohol solution. Genotyping was performed by TaqMan, and data were analyzed by ANOVA with rearing and genotype as independent variables. Carriers of the variant allele had higher intoxication scores. There was also a rearing by *GABRA6* genotype interaction on alcohol self-administration. Nursery-reared macaques carrying the variant allele did not exhibit upregulated alcohol self-administration relative to homozygotes for the ancestral allele. Although little has been done to examine *GABRA6* variation as it relates to alcohol abuse or dependence in human subjects, our data support a role for this SNP in protecting against early stress-induced increases in alcohol intake, suggesting that damaging variation at this gene could serve a protective role for alcohol missuse in human subjects.

Abstract # 169

PRIMATE SOCIOGENOMICS: HOW SOCIAL BEHAVIOR CHANGES THE GENOME IN OLD WORLD MONKEYS

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In social primates, interactions with group mates powerfully shape the environment that individuals face each day. Consequently, some of the most important sources of variance in individual fitness involve aspects of the social environment. Here, I present two examples from our efforts to understand the molecular mechanisms that mediate these effects. First, I discuss evidence from experimental work in captive rhesus macaques (*Macaca mulatta*). Our findings indicate that social status (i.e., dominance rank) in adult females causally alters gene regulation in immune cells, in a manner that is both cell type-specific and highly plastic. Social status also influences the gene expression response to infection: low ranking females mount a stronger pro-inflammatory response than high ranking females, indicative of rank-driven polarization of the Toll-like receptor 4 signaling pathway. Second, I present evidence from an intensively studied wild baboon (*Papio cynocephalus*) population that gene regulation is also associated with social environmental variation in unmanipulated natural populations. In this context, social status-linked immune gene regulation is more detectable in adult males than in adult females, consistent with previous findings in this population showing stronger physiological consequences of rank for males. Together, our results point to a strong link between social behavior and the genomics of the immune system, with important ramifications for understanding both social gradients in health in humans and the evolution of social hierarchies more broadly.

Abstract # 170

EXPLORING THE SHARED GENETIC CONTRIBUTIONS TO *PERSONALITY* AND BRAIN STRUCTURAL COVARIATION IN CHIMPANZEES (*PAN TROGLODYTES*)

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A converging literature suggests that both human and nonhuman primates possess a largely consistent set of heritable neurobiologically-based *Personality* traits. To date, however, direct investigations of the joint heritability of *Personality* traits and associated *Neuroanatomy* are scarce. The current research thus aimed to examine the extent to which associations between *Personality* traits and *Neuroanatomy* was a result of shared genetic effects among 188 socially-housed, captive chimpanzees. Specifically, using source-based morphometry (SBM), a multivariate analysis of naturally occurring patterns of covariation of grey matter across the brain, we 1) investigated associations between independent structural components and *Personality*, 2) estimated the genetic contributions to variation in each, and 3) investigated the extent to which phenotypic associations were a result of a set of common genes (i.e.,genetic correlations [?G]). Associations between Openness and Extraversion and a component that included fronto-parietal regions and between Extraversion and a component that included limbic regions emerged. Both *Personality* traits and associated SBM components were found to be heritable and, further, covariation between *Personality* traits and SBM components were found to result from shared genetic influences (Mdn ?G = .61). The current research provides an example of the power of chimpanzees in the search for the neurobiological basis of *Personality* with direct translational relevance to humans.

Abstract # 177

PRIMATE FAMILIES: SOCIAL MONOGAMY, COOPERATIVE BREEDING, AND ASP

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The study of primate families encompasses many different fields of enquiry, including behavior, physiology, ecology, neurobiology, and conservation. Socially monogamous and cooperatively breeding primates share many aspects of behavior, but these are regulated by diverse neurobiological mechanisms and shaped by convergent evolution. In my research, I have focused on pair bonding and infant care behavior by mothers, fathers, and siblings. Initially I studied these behaviors in laboratory common marmosets, and then in wild golden lion tamarins using fecal hormone analysis. Since 2004, my students and I have studied the mechanisms of pair bonding and parenting in titi monkeys at the California National Primate Research Center. We have examined the neural basis of pair bonding using PET imaging and other neurobiological techniques. In addition, we study the consequences of human clinical use use of oxytocin, the hormone responsible for pair bonding and parenting. Finally, our other primate family, ASP, has been central to my career and my science.

Abstract # 185

MARMOSETS AS A TRANSLATIONAL *AGING* MODEL

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Interests in the *marmoset* as a nonhuman primate *aging* model begin to accelerate in the mid-2000s. Because marmosets have a fast maturation and short life span compared with more commonly used Old World monkey models, such as macaques, the *aging* research community began to explore the potential for this species as a translational *aging* model. In addition, the relative ease with which marmosets can be bred in a barrier environment enhances their value as a life-span model. Since that time, efforts to better define what *aging* actually looks like in marmosets has intensified and while we have a much better picture of *marmoset aging* that we did a decade ago, we still have much to explore before we have taken full advantage of the potential of this model. Important findings of the past decade include: (1) a refined definition of lifespan in this species and what affects age-specific survival; (2) assessments of age-related pathological changes; (3) development of functional phenotyping relevant to *aging*, such as activity, strength, body composition, cytokine profiling; (4) support of studies using the *marmoset* as a preclinical model to test intervention that may modulate the *aging* process.

Abstract # 186

THE COMMON MARMOSET (*CALLITHRIX JACCHUS*) AS A MODEL FOR AGE-RELATED HEARING LOSS

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The effects of aging on the auditory system of the common marmoset (*Callithrix jacchus*) have received limited attention despite the wide-spread use of this species in hearing research. Here, we address this by assaying cochlear and brainstem function in forty seven marmosets between 1-12 yrs old. To assay cochlear function, we measured distortion-product otoacoustic emissions (DPOAEs) and wave-I of the auditory-brainstem response (ABR), which reflect the health of the 'cochlear amplifier' (outer hair cells; OHCs) and cochlear nerve fibers, respectively. To assay brainstem function, we analyzed the amplitude and latency of ABR peaks with central generators (waves II-V). In monkeys older than 6 yrs, the severity and pattern of ABR threshold shifts (re young) varied substantially. Older animals with normal ABR thresholds had normal cochlear function, and those with elevated ABR thresholds had degraded cochlear function. Regardless of cochlear status, older animals showed signs of central deficits, including reduced peak II-V amplitudes and prolonged inter-peak intervals. The data suggest that the susceptibility of individual marmosets to age-related cochlear deficits varies, but that central auditory processing may be compromised in older monkeys regardless of the status of the peripheral auditory system.

Abstract # 187

HIGH-RESOLUTION METABOLOMICS TO MONITOR METABOLIC RESILIENCE IN MARMOSET AGING

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We previously reported cross sectional and longitudinal changes associated with aging for plasma metabolomics in 200 marmosets collected over 5 years. We have initiated studies of metabolic network structures to determine whether these can be used to evaluate changes in metabolic resilience with aging. The central concept is that metabolic adaptability depends upon the ability of a system to adjust to stresses; a more irregular state with many connections has better ability to tolerate stress. We selected metabolic networks of methionine (Met) for initial study because Met is an essential amino acid readily measured in all marmosets and prior studies in rodents showed that Met restriction can promote lifespan. We used pathway connections and network diameter as indicators of resilience. Results comparing 32 females >7 years old to 74 females <7 years old showed decreased Met pathway connections and greater network diameters for older marmosets ($p<0.05$). A similar pattern was seen in males but results were not significant. In a cross-over dietary study (n=8), a diet with low Met resulted in greater connectivity and decreased network diameter compared to high Met diet. These results show that network diameter varied as expected in association with age and improved diet and provide a foundation for experimental studies to evaluate interventions to improve resilience in aging.Research Support by National Institute of Aging (AG038746).

Abstract # 188

HORMONAL MODULATION OF NEUROCOGNITIVE AGING IN MARMOSETS (CALLITHRIX JACCHUS)

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This presentation will discuss the hormonal modulation of cognition in marmosets, particularly in the context of aging and menopause. I will first present data from an ongoing longitudinal study showing sex differences in cognitive performance, stress reactivity and brain neurochemistry (as assessed by MRS) in middle-aged marmosets. The second part of the talk will focus on the effects of estrogen manipulations in the surgically menopausal female marmoset. I will show that estrogens not only affect cognition and stress reactivity, but also sleep and temperature patterns, underlining the importance of integrating multiple measures from the same animal for a better understanding of the impact of estrogen loss on aging patterns. Finally, I will present recent evidence that estrogen synthesis inhibition has detrimental effects on cognition, thermoregulation and neuronal physiology, suggesting an important contribution of neurostrogens in age-related cognitive decline. Overall, the results of these studies support the use of the marmoset as a translational model for neurocognitive aging. Supported by NIH R01 AG046266.

Abstract # 189

DEVELOPMENT OF TRANSGENIC MARMOSET MODELS OF BRAIN FUNCTION AND NEURODEGENERATIVE DISEASES

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Optical monitoring of neuronal populations tagged with fluorescent calcium-sensitive molecules has become an attractive way to study brain function in vivo, particularly after the development of genetically encoded calcium indicators (GECIs). GECI molecules sense calcium influx into excitable cells. Upon calcium binding, GECI molecules fluoresce, constituting a visible marker of cellular function and activity. The most optimized family of GECIs to allow monitoring of neural activity in vivo are GCaMP, which are based on a fusion of the calcium-binding protein calmodulin with the green fluorescent protein (GFP). Of all nonhuman primates, marmosets (*Callithrix jacchus*), an important nonhuman primate model in neurophysiological research, are the ideal species for two-photon microscopy experiments, because of their lissencephalic cortex and thin skull. We have successfully generated transgenic marmosets that were engineered to express GCaMP molecules under control of either the CMV or the hSyn promoter. High titer lentiviral vectors were produced, and injected into embryos collected from donor females. The infected embryos were then transferred to recipient females. Eight transgenic animals were born and shown to have stable and functional GCaMP expression in several different tissues. Germline transmission of the transgene was confirmed in embryos generated from two of the founder transgenic marmosets that reached sexual maturity. These embryos were implanted into six recipient females, three of which became pregnant and gave birth to five transgenic marmosets of the F1 generation. We are also using the latest gene editing techniques, such as CRISPR/cas9, to make a marmoset model of the monogenic stroke-like disease CADASIL (Cerebral Autosomal Dominant Arteriopathy with Subcortical Infarcts and Leukoencephalopathy). We believe these transgenic marmosets will be invaluable non-human primate models in neuroscience, allowing chronic in vivo monitoring of neural activity with functional confocal and multi-photon optical microscopy imaging of intracellular calcium dynamics.

Abstract # 190

THE FUTURE OF MARMOSET AGING RESEARCH, INTERVENTION TESTING AND BEYOND

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Marmosets are an emerging model in which to examine aging and age related disease progression. The talks in the symposium will summarize current knowledge of phenotypic aging as well as the state of the field. There are many other avenues for future research to explore beyond the initial stages of phenotype characterization of aging in the marmosets including the examination of interventional therapies such as drug testing and genetic manipulation. A few cases will be highlighted including the drugs rapamycin and

metformin. Rapamycin is an mTOR suppressor which in many ways mimics the effects of caloric restriction in the signaling pathways. The results of its actions include the extension of longevity and healthspan in mouse models. Efficacy testing of rapamycin in marmosets has revealed that the animals tolerate the drug and that there are no obvious detrimental effects. Current and future work hopes to examine the effects of rapamycin on longevity and health in the marmoset. Metformin is a drug that stabilizes blood glucose and general metabolic health and is proposed as a potential anti-aging drug which is being tested in the marmosets. Additionally, researchers are exploring the development of genetic models of disease and disease progression associated with aging in the marmoset. This final talk in the symposium will present what is currently known and the future directions of marmoset translational research.

Abstract # 194

EARLY LIFE MEASURES OF TEMPERAMENT PREDICT HAIR CORTISOL AND RANK ATTAINMENT FOLLOWING NEW GROUP FORMATION IN CAPTIVE RHESUS MACAQUES (*MACACA MULATTA*)

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Group fusions, in which two formerly separate social groups merge, have been documented in several species of cercopithecines; yet while social behavior after group fusion has been described, little is known about how individuals differ in their responses to group fusions. We report on a management-directed new group formation in captive rhesus macaques (*Macaca mulatta*) as a model of group fusion. We examine whether interindividual differences in temperament during infancy affect physiological and social responses to new group formation years later, measured through hair cortisol and rank attainment 9 mos after “group fusion”. The new group comprised 111 individuals. Subjects included all individuals present for hair sample collection and whose temperaments had previously been profiled (n = 45). Animals were sometimes removed from the group for medical or management purposes, reducing sample size at 9 months after group formation (n = 22). Individuals’ ages and ranks were obtained from colony records. Our results show that early-life measures of emotionality and activity predict later-life hypothalamic-pituitary-adrenal activity and rank attainment in response to new group formation. Individuals characterized in infancy as more emotional (multiple linear regression, alpha=0.05) and more active (alpha=0.05) exhibited lower hair cortisol profiles after 9 mos. Individuals characterized in infancy as more active (alpha=0.05) attained higher rank after 9 mos. Our results demonstrate that temperament measures in infancy can predict individual outcomes years later.

Abstract # 195

DEVELOPMENT OF INDEPENDENCE IN AN INFANT WESTERN LOWLAND GORILLA (*GORILLA GORILLA GORILLA*) AT THE PHILADELPHIA ZOO

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Ape development is unique compared to other species. Infant and juvenile stages are longer in apes than in other mammals due to higher cognitive functioning and longevity of care. However, there are still gaps in our knowledge of these critical life stages. We investigated the development of independence and relationship building in an infant female western lowland gorilla from birth to six months. During 30-minute focals (18.23 hours), we used a combination of instantaneous and all occurrences sampling to record activity budget behaviors of the mother/infant pair as well as proximity to other individuals in the group (1 adult female and 1 silverback). We found that the infant spent 91% of her time in contact with her mother. However, we found that contact time decreased over the six months ($R2 = 0.85$, $F(1,5) = 29.21$, $p < 0.003$). We also found that far-distance (> 5m) between the mother/infant pair and both the other female and the silverback decreased over the six months ($R2 = 0.62$, $F(1,5) = 8.15$, $p < 0.04$; $R2 = 0.65$, $F(1,5) = 9.29$, $p < 0.03$,

respectively). In summer 2017, a second infant is due in this group and we plan to include it in this mother-infant study. Our research aims to add to the body of literature on infant development in captive gorillas.

Abstract # 196

EFFECTS OF MATERNAL-INFANT GAZING ON INFANT NEUROBEHAVIORAL DEVELOPMENT IN SOCIALLY HOUSED RHESUS MACAQUES (*MACACA MULATTA*)

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An increasing number of studies are examining the effect of mother-infant interactions on infants' development. Current studies have shown relationships between rates of mother-infant mutual gazing and infants' sociality, as well as hair cortisol concentrations at weaning. This study aimed to examine the effect of mutual gazing on infants' neurobehavioral development. Face-to-face interactions between rhesus macaque mother-infant dyads (N=20, 12 male) were observed 3x/week for the first 30 days of life. In addition, each infant was administered the Primate Neonatal Neurobehavioral Assessment (PNNA) on days 14±2 and 30±2 postnatal. Composite scores were generated using the results of the PNNA to assess specific neurobehavioral developments. Infants who engaged in higher rates of mutual gaze (MG) scored higher on PNNA Attention tasks (r=0.453, p=0.045) while infants with lower rates of MG (r=-0.496, p=0.026) scored higher on Body Control tasks. Due to the known sex bias rhesus macaque mothers exhibit in face-to-face interactions, we chose to examine the relationship between gazing and neurobehavioral development separately for sons and daughters. Sons with higher rates of MG scored lower in both Body Control (r=-0.673, p=0.016) and Activity (r=-0.642, p=0.024) tasks, while daughters with higher rates of MG scored higher in Sensorimotor (r=0.868, p=0.005), Attention (r=0.949, p=0.000), and Reflex (r=0.719, p=0.044) tasks. These data, along with the existing literature, further define the link between differential maternal investment and infant developmental outcomes.

Abstract # 197

CAREGIVER RESPONSES TO INFANT LION TAMARIN BEGGING VOCALIZATIONS ARE INFLUENCED BY GROUP SIZE, INDIVIDUAL AGE, SEX, AND REPRODUCTIVE STATUS

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Infant begging vocalizations may increase resource allocation if caregivers attend to this behavior. In cooperatively breeding animals, begging vocalizations may not solicit care equally as the distribution of infant care differs among caregivers. We evaluated the extent to which caregiver responses to infant vocalizations varied with genetic, behavioral, morphological, reproductive and ecological conditions. The study was conducted on five groups of wild golden lion tamarins,*Leontopithecus rosalia*, at Poço das Antas Biological Reserve, Brazil. Once per week we presented caregivers with vocalizations recorded from infants two to nine weeks of age from natal and neighboring groups. Although we did not find a difference in caregiver response rate or intensity based on familiarity or relatedness to the infant, response rate was influenced by reproductive status, sex, condition, experience, group size and activity level. Reproductive individuals, especially males, were more likely to respond to infant calls, as were less-experienced reproductive females (Chi squares $p<.0001$, $p<.002$, and $p<.0001$, respectively). Reproductive females and nonreproductive males that were heavier than average for their sex and age class were also more likely to respond (Chi square $p<.04$ and $p<.006$, respectively). The diversity of non-genetic factors effecting variation in caregiver responses to infant vocalizations suggests that these responses are flexible and dynamic, shifting with changes in group composition and context and with individual reproductive status and physical condition.

Abstract # 198

TWINNING AND EVIDENCE FOR HETEROPATERNITY IN RING-TAILED LEMURS (*LEMUR CATTA*) FROM ST. CATHERINES ISLAND, USA

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With the exception of a few taxonomic groups (e.g., callitrichids, ruffed lemurs), having more than one offspring per birth event is rare for most primates. In the ring-tailed lemur (*Lemur catta*), although single-offspring births are the norm, twinning can occur under food-rich conditions. As such, twinning is a relatively common occurrence in captivity, but has also been noted in wild populations of this species. In this study, we evaluated the paternity of twins born to a food-provisioned but free-ranging population of ring-tailed lemurs on St. Catherines Island, USA across a four-year period (2010-2013). Females in this species can mate with multiple males while in estrus, often in close temporal succession, but the presence or absence of heteropaternity (twins having different sires) had heretofore not been evaluated in this species. Using multilocus microsatellite genotyping and paternity exclusion methods, we found that in the majority of cases (11 of 14 sets of twins), infants shared the same sire (binomial test: $p = 0.022$), but our data also revealed 3 cases of heteropaternity. Somewhat surprisingly, all 14 sets of twins were found to be dizygotic (fraternal), as evidenced by each individual in a twin pair having a unique multilocus microsatellite genotype. Because previous genetic data gathered on wild ring-tailed lemurs found evidence for identical twins, both monozygotic and dizygotic twinning have now been genetically confirmed in this species.

Abstract # 200

THE EFFECT OF INDIVIDUAL DIFFERENCES ON CALLING RATES ACROSS THE VOCAL REPERTOIRE OF THE MALE RING-TAILED LEMUR (*LEMUR CATTA*)

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Understanding how vocal repertoires are used by individuals leads to a better understanding of the cognitive capacities of social species. In strepsirrhine primates, it is largely unknown how inter-individual differences relate to vocalization usage. To investigate, I studied the ring-tailed lemur (*Lemur catta*), a gregarious strepsirrhine with a large vocal repertoire. My study explored the relationship between individual age, dominance rank, and vocalization rate for all calls across the vocal repertoire of the male ring-tailed lemur. In 2010, 565 hours of focal data were collected from 31 males aged 1 and older from Beza Mahafaly Special Reserve, Madagascar. High-ranking males had higher vocalization rates for calls used in aggressive agonistic interactions (Multiple regression tests: purr, $b=0.006$, $SE=0.001$, $t_{2,28} =3.895$, $p=0.001$; squeal, $b=0.007$, $SE=0.002$, $t_{2,28}=4.168$, $p<0.001$). Low-ranking males had higher vocalization rates for some affiliative and some submissive agonistic calls (hmm, $b=-0.0217$, $SE=0.00816$, $t_{2,28}=-2.66$, $p=0.0128$; yip, $b=-0.011$, $SE=0.004$, $t_{2,28}=-2.484$, $p=0.019$). Young males had higher vocalization rates for an affiliative call (chirp, $b=-0.044$, $SE=0.022$, $t_{2,28}=-2.027$, $p=0.05$). My results indicated that when call usage across behavioural contexts was considered, there were patterns in ring-tailed lemur vocalization rates that varied with age and dominance rank. With the ring-tailed lemur as one of the best living models of social primate ancestors, understanding how vocal repertoires are used on an individual level informs our understanding of the evolution of primate sociality.

Abstract # 201

THE ADAPTIVE VALUE OF SOCIO-COMMUNICATIVE BEHAVIOR

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Human spoken language represents the most elaborate communication system, however the selection pressures that led to its emergence are still uncertain. Unlike humans, bonobos and chimpanzees do not have language. However, bonobos may have been subjected to similar selection pressures as early hominins, subsequent to to their phylogenetic split from chimpanzees roughly 1.5 million years ago, Therefore, bonobos may be useful models for the evolution of complex communication and sociality in humans. The current study investigates the similarities and differences in sociality and communicative production between bonobos and chimpanzees in captive settings. In order to access communicative production and sociality, 10, 10-minute focal follows are conducted on each individual from a quasi-randomized list. Preliminary data suggest bonobos and chimpanzees differ significantly in vocal ($p=0.010$), gestural ($p=0.002$), and concomitant ($p=0.024$) signal production but not in overall communicative production ($n=8$, $n=8$). Specifically bonobos produced more vocalizations while chimpanzees produced more multimodal signals. These data are consistent with previous findings that bonobos rely more heavily on auditory communication, have greater flexibility in their vocal production, and have larger vocal repertoires than other ape species. These differences in vocal production between the two species can provide insight into the evolutionary origins of human spoken language, and present a unique model for the selection pressures faced by early hominins.

Abstract # 202

STRESS AS A COST OF SOCIALITY IN WILD *PONGO PYGMAEUS WURMBII* IN GUNUNG PALUNG NATIONAL PARK, WEST KALIMANTAN, INDONESIA

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Constrained by poor fruit availability in Southeast Asian rainforests, orangutans are considered semi-solitary. While studies give the impression of general social aversion, orangutans in Gunung Palung National Park (GPNP) do form associations, particularly during periods of high fruit availability. To better understand the mechanisms that modulate sociality, we examine the possibility that socializing is stressful by exploring social anxiety (as measured by self-directed behavior) and stress more generally (through urinary cortisol) among different age-sex classes under social and solitary conditions. Data were collected in GPNP from 1994-2009 and 2013-2014 during day-long focal follows. Urine was collected from the first morning urination and analyzed by EIA for cortisol (N=745). All instances of self-directed behavior (SDB), including self-scratching, yawning, and self-grooming, were recorded during ten-minute 'SDB follows' (N=1,534). Overall, orangutans had higher rates of SDB and cortisol when they were social than when they were alone ($t(1331.41) =3.068$, $p=0.002$; $t(892) =2.501$, $p=0.013$, respectively). GLMMs revealed that age-sex class significantly influences SDB and cortisol, with nulliparous females having the highest rates of SDB (AIC=0.250, $p<0.001$) and parous females having the highest cortisol concentration (AIC=141,335.39, $p=0.006$). We found evidence that nulliparous females may serve as social buffers for one another. We discuss the changing costs and benefits of socializing over the life span and the potential utility of SDB for assessing the quality of relationships in wild orangutans.

Abstract # 203

CENTRALITY AND SOCIAL POWER: INDIVIDUAL ROLES IN A SOCIAL NETWORK OF A CAPTIVE GROUP OF HAMADRYAS BABOONS (*PAPIO HAMADRYAS*)

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Studying intragroup interactions of group-living species in captivity provides insights into group cohesion that may aid in providing optimal care. Social network analysis (SNA), which utilizes quantitative measures of group systems to represent how social interactions influence group structure, may aid in this endeavor. To understand the effect of an introduction on group cohesion, we examined the network of a group of hamadryas baboons (*Papio hamadryas*) at Oakland Zoo after the introduction of two juvenile males. We hypothesized that centrality of the males would increase as they were integrated into the group. We collected data using all-occurrences event-sampling of all social interactions (N=14 individuals) from July-December 2016 (113 hrs.). Three measures of centrality were utilized: betweenness, closeness, and eigenvector centrality. Neither of the new males showed a significant change in closeness over time. Both males showed a decrease in eigenvector centrality ($p=0.0093$, $p<0.0001$) and one of the males showed an increase in betweenness ($p=0.035$), while the other did not. The decreases in eigenvector centrality indicate that the new males decreased their interactions with central individuals. However, the increase in betweenness by one male indicates that he has a growing intermediary role in the network and therefore increasing social power. These males are still young and measures may continue to change as the males mature and develop harems of their own.

Abstract # 204

EVALUATING THE ASSOCIATION BETWEEN RELATIONSHIP SATISFACTION AND PHYSIOLOGICAL LINKAGE IN HUMAN COUPLES (*HOMO SAPIENS*) AND PAIRS OF SOCIALLY MONOGAMOUS TITI MONKEYS (*CALLICEBUS CUPREUS*).

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Psychological theories suggest that coordination develops between adult attachment partners in behavior, emotion and physiology. Autonomic nervous system (ANS) linkage is hypothesized to convey positive relationship outcomes such as satisfaction and longevity. Literature from human couples finds mixed support, in part due to experimental control limitations. We examined the association between physiological linkage and relationship satisfaction in humans and socially monogamous titi monkeys. Data from married couples (N=120) was collected in California in 1989 and data from titi pairs (N=6) was collected at the California National Primate Research Center. Relationship satisfaction for humans was measured via self-report and for titis was assessed with a partner preference test. ANS physiology was measured in both studies via simultaneous electrocardiography recording from both partners (humans- 45 min.; titis-15 min.). We correlated across partners' inter-beat interval (IBI) series using a 25-sec.moving window and counting the frequency of linkage moments (i.e. windows) with moderate ($-0.3 < r > 0.3$) cross-partner IBI correlations. A dyadic mixed model revealed that highly satisfied couples also had a high frequency of linkage moments ($p<0.05$). Preliminary results are similar in titi pairs with stronger partner preference associating with more frequent linkage moments ($p<0.05$). These results support the hypothesis that ANS linkage within adult attachment bonds relates to positive relationship outcomes and may not be exclusive to human relationships.
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Abstract # 205

CHANGES IN ASSOCIATION OF AGING WILD MALE CHIMPANZEES (*PAN TROGLODYTES SCHWEINFURTHII*) OF THE KANYAWARA COMMUNITY, KIBALE NATIONAL PARK, UGANDA

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In chimpanzees, males cooperate more frequently and form stronger bonds than females. These bonds are important in gaining and maintaining dominance rank, which is important for reproductive success. While male rank peaks around 30 for adult male chimpanzees, not much is known about how male affiliation changes with age. We predict that male association will decrease with age as social bonds become less important given the reduction in rank. Using 21 years of data on the Kanyawara community, we analyzed spatial and temporal association of male chimpanzees in one year periods to calculate a combined association index (CAI) and determine the number of preferred social partners (PSP) for each male in each year. Age had no effect on average CAI ($p = 0.271$) nor on number of PSPs ($p = 0.592$) when controlling for rank. However, there was an interaction between age and rank ($p < 0.001$) such that low ranking prime age (15-35) males have low association compared to high ranking prime age males, while past prime age (35+) males have the same association regardless of rank. Interestingly, older males had higher CAI with partners closer to their age ($p < 0.001$), suggesting that older males form stronger bonds with age-matched partners, regardless of their rank. These results suggest that male social bonds are important for older males for reasons independent of rank acquisition.

Abstract # 206

ECOLOGICAL CORRELATES OF SOCIAL BEHAVIOR IN WILD BONOBOS (*PAN PANISCUS*)

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The complex relationship between ecology and social structure has been long studied in primates. In bonobos (*Pan paniscus*), research has highlighted the importance of aspects of feeding competition in the evolution of female social cohesion. Here, we examined how different ecological measures correlate with affiliative, aggressive, and sexual behaviors. We collected ecological data on 133 visits to food patches and interaction data over 242 hours on three bonobo communities at the N'dele site in the Lomako Forest, DRC. We used non-parametric correlations to assess the relationship within ecological variables, within social behavior, and between ecological variables and social behavior. A stepwise regression model was also used to examine the relationship between ecology and social behavior. We found several correlations within ecological variables including tree radius with amount of food removed from a patch ($p < 0.001$) and party size with amount of food removed ($p < 0.001$). We also found several correlations within social behavior including GG rubbing with mating ($p < 0.001$) and male-male aggression with male-male grooming ($p < 0.001$). Our regression analysis revealed that amount of food removed from a food patch predicted GG rubbing, female-female grooming, male-female grooming, and mating frequency ($p < 0.05$). These results highlight the close relationship between high food patch quality and strong affiliation in wild bonobos.

Abstract # 207

HOW DO A MALE'S PHYSIOLOGICAL AND SOCIAL PROFILES PREDICT RANK DURATION AND MATING SUCCESS?

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Dominance rank has profound consequences for male reproductive success in many species. The length of time a male remains at high rank is an important predictor of male fitness. However, we currently have only a limited understanding of why some males stay at high rank longer than others. To investigate predictors of high rank tenure and mating success, we used longitudinal data from adult male baboons (*Papio cynocephalus*) in the well-studied Amboseli baboon population in Kenya. We tested two hypotheses: one that predicts that the burdens of high rank lead to shorter rank tenures, and another that predicts that only the highest quality males can withstand the burdens of high rank, and subsequently maintain the longest rank tenures. Our results revealed that for high-ranking males, social connectedness was a significant predictor of high rank duration [survival time-varying analysis; alpha <0.001] and mating success [linear mixed model: alpha <0.001] and that these patterns were mediated by demographic and ecological factors including group

size, sex ratio, and rainfall. We discuss these results in the context of inter-individual variation in male fitness and the evolution of male reproductive strategies.

Abstract # 209

CAUSES OF INFANT MORTALITY AND MATERNAL RESPONSES TO INFANT DEATH IN WILD CHIMPANZEES (*PAN TROGLODYTES*)

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Chimpanzee mothers have been reported to show a diversity of responses to the death of their infant, which raises questions about what they understand about death. To examine variation in maternal responses to death, we used the largest known dataset of wild chimpanzee infant mortality at Gombe National Park. Out of 87 infants (< 5 years of age) observed between 1964 and 2016, 31 disappeared and cause of death could not be confirmed. In the 56 remaining cases, causes of infant mortality were: infanticide (29%), illness (20%), lack of appropriate maternal care (13%), being orphaned (13%), injury (5%), and poaching (2%). In 5 cases infants were dead upon first observation, and in another 6 cases, infant death was observed but the cause of death was unknown. For 36 cases, the mothers' response to infant death was observable and ranged from participating in consumption of the corpse after infanticide to carrying the corpse for over two weeks. Here we explore potential sources of variation in maternal responses, as well as how maternal behavior changed over time in those cases wherein extended interaction with the corpse occurred. These data will provide valuable insight into what chimpanzees may understand about mortality.

Abstract # 210

MUSCULOSKELETAL GROWTH IN WILD CHIMPANZEES WITH IMPLICATIONS FOR SOCIAL BEHAVIOR

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Developmental data from our closest living relatives are of particular interest for identifying which aspects of human life history are derived. To date, most of our knowledge of chimpanzee growth comes from data on captive populations despite indications that these individuals develop faster than their wild counterparts. In this study, we examine patterns of growth among wild chimpanzees of the Kanyawara community in Uganda. From 2012-2014, body size estimates were acquired for over 50 individuals using parallel laser photogrammetry to calculate trunk lengths (as measures of linear growth) and cross-sectional trunk area (as an approximation of body weight). Two important patterns of chimpanzee growth emerge from this study. First, compared to captive populations, wild chimpanzees exhibit a delayed adolescent growth spurt as well as an extended adolescent growth period. Second, male body size measures indicate that 10-year olds maintain body lengths within the range of those exhibited by adult males, but their body areas fall below the adult male range and only reach adult sizes between the ages of 15-17. This indicates that skeletal growth is likely completed before the addition of muscle mass for these males. The adult skeleton size is achieved during a period of social transition away from adult mothers while the increase in muscle mass is occurring after males have been socially integrated into the adult male hierarchy.

Abstract # 211

FACTORS INFLUENCING DEVELOPMENTAL ENAMEL DEFECTS UNDERSTOOD TO RECORD STRESS IN WILD GREAT APES

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Linear enamel hypoplasia (LEH) is a common developmental defect on the outer tooth surface, and is associated with stressors like malnutrition or illness. We recently showed that LEH are more common in mountain gorillas than previously recognized, but they are significantly shallower than in other apes (p=<0.001). While shallow defects are assumed to reflect reduced stress severity, enamel geometry may also influence defect morphology. In canine histologic sections of wild Virunga mountain gorillas (N=3) and other great apes (N=6), we measured the angle with which enamel growth increments approach the outer tooth surface. We found that mountain gorillas have significantly shallower striae angles than other apes (ANOVA, p=0.027), which may reflect faster enamel secretion rates and contribute to comparatively shallow defects. Within mountain gorillas, we compared LEH depth among naturally accumulated skeletons collected by Dian Fossey (Smithsonian's NMNH; 1968-1974) and those collected recently (Mountain Gorilla Skeletal Project, Rwanda; post-1996). The gorillas collected by Fossey (N=17 defects; mean depth=25.8 μ) have deeper defects than those that lived more recently (N=79 defects; mean depth=19.6 μ; Welch's t-test, p=0.059). These results suggest that variation in defect expression among great ape teeth likely reflects the combined influence of enamel geometry and stress. Future studies incorporating associated records will provide the first data on LEH etiology in gorillas. NSF (IGERT 0801634; BCS 0852866, 0964944, 1520221,1613626), The Leakey Foundation, NGS (8486-08)

Abstract # 212

MIXED EVIDENCE FOR ECOLOGICAL RISK AVERSION IN JUVENILE WILD CHIMPANZEES (*PAN TROGLODYTES SCHWEINFURTHII*) AT GOMBE NATIONAL PARK, TANZANIA

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The ecological risk aversion hypothesis (ERAH) proposes that prolonged primate juvenescence is a response to predation and starvation risks. To avoid predation, juveniles maintain close proximity to adults, increasing competition and limiting foraging efficiency. Slow growth minimizes juveniles' metabolic needs, diminishing subsequent starvation risk. However, past studies investigating the ERAH in wild primates have yielded mixed results. Here, we use 26 months of observational data from Gombe National Park, Tanzania to test the ERAH in wild chimpanzees by comparing the time juveniles spent in close proximity to conspecific adults while feeding and resting. Because predation risks theoretically decrease with increased body size, we predict that juvenile proximity to adults will decrease as they age. Additionally, we expect juveniles to spend more time in close proximity to adults while feeding and resting terrestrially than arboreally because the ground likely poses higher predation risk. Contrary to our predictions, juvenile proximity to adults increased with juvenile age ($F_{1,12.21}=15.12$; $p=0.02$). However, supporting our predictions, juveniles spent more time in close proximity to adults while resting terrestrially than arboreally ($F_{1,52.97}=7.51$; $p=0.01$), but not while feeding ($F_{1,51.97}=1.08$; $p=0.30$). This pattern suggests that resting may be riskier than feeding, when individuals are upright and may be more vigilant for conspecific competition and predators. Other factors, such as social opportunities and resource distribution, may also contribute to patterns of juvenile proximity to adults.

Abstract # 213

EXPLAINING PLAY PARTNER PREFERENCES AMONG KANYAWARA CHIMPANZEES: ARE MALES SPECIFICALLY TARGETED AS PARTNERS OR ARE THEY SIMPLY MORE WILLING TO PLAY?

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Like male children, young male chimpanzees exhibit rougher play styles than females (Meaney et al. 1985). Among children this contributes self-organized same-sex play, reflecting both same-sex partner preferences and female avoidance of rough-and-tumble of male play-styles (Martin et al. 2005). However, among immature chimpanzees at Kanyawara, both sexes seem to prefer male partners after controlling for availability (Sabbi et al. 2016). In this study we ask: can this pattern be explained simply by increased willingness to play among males? Or do both sexes specifically target male partners in lieu of females? We observed 740 play bouts among immature chimpanzees (n=24,15 females, 9 males) of the Kanayawara community in Kibale National Park, Uganda from January-August 2015. For each bout, we recorded identity, age, and sex of initiating and target partners; and manner of play initiation and termination. There was no sex difference in total play bouts (T-Test, p=0.44), or bouts initiated per hour (T-Test, p=0.79). Males and females also terminated play bouts (T-Test, p=0.73) and rejected play bout solicitations at relatively equal rates (T-Test, p=0.89). However, when play bouts ended in switching partners, males were more likely to be selected as new partners (X2=7.183, p=0.0475). Thus, females were not less playful or less willing to play than males, supporting the conclusion that males were actively preferred partners of both males and females.

Abstract # 214

MATERNAL GREGARIOUSNESS DURING EARLY INFANCY PREDICTS OFFSPRING SOCIAL PATTERNS IN ADULTHOOD IN WILD CHIMPANZEES

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Studies from a number of species have shown that social experiences during early life shape adult social behavior. Mothers play a particularly important role in the social development of their offspring, as they are not only a primary social partner, but can also facilitate or restrict infant social interactions with others. Due to the fission-fusion grouping patterns of chimpanzees (*Pan troglodytes*), mothers can move fluidly into and out of subgroups, allowing for large variation in offspring social exposure within the community. In this study, we analyzed 42 years of data on the Kasekela community in Gombe National Park, Tanzania to investigate the relationship between maternal gregariousness during infancy (early: first six months, N=14 individuals; late: 6 months to 3.5 years, N=18 individuals) and male offspring social patterns in early adulthood (15 – 20 years of age) when males travel independently from their mothers, and enter the adult hierarchy. We found that the proportion of time mothers spent alone during early ($F_{1,61.84}$=4.57; p=0.03), but not late infancy ($F_{1,14.53}$=1.12; p=0.39), significantly predicted the proportion of time male offspring spent alone as young adults. Notably, early infancy corresponds to the period in which mothers show the greatest variation in gregariousness in this community and may be a critical period for epigenetic effects on social behavior. Future work will relate male gregariousness to measures of reproductive fitness.

Abstract # 215

SOCIAL BONDS DURING THE TRANSITION TO ADULTHOOD IN MALE CHIMPANZEES

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Social bonds play an important role in primate behavior, including in the lives of adult chimpanzees (*Pan troglodytes*). Social bonds between adult male chimpanzees are key for cooperation and are formed with maternal brothers and non-relatives, especially peers. Despite their importance in adulthood, little is known about when social bonds develop. Bonds may emerge during adolescence or only later, during adulthood, when male chimpanzees become more gregarious and begin competing for dominance status. To investigate the development of social bonds, I studied the behavior of ten adolescent and eight young adult male chimpanzees at Ngogo, Kibale National Park, Uganda. To assess the effects of age, age difference, and kinship on the formation of social bonds, I conducted generalized linear mixed models. Adolescent male chimpanzees formed social bonds with other males, and they did not differ from young adult males. Adolescent and young adult males formed association and proximity relationships with maternal brothers. In general, adolescent and adult males were more likely to associate, spend time in proximity, and groom with old males rather than middle-aged adults. Unexpectedly, some of strongest grooming relationships were between fathers and sons. Because chimpanzees mate promiscuously, there is no reason to suspect that chimpanzees can recognize their fathers or that fathers can recognize their sons. These findings raise the possibility that fatherhood may have evolved from an ape-like social system.

Abstract # 216

CHALLENGES DURING THE POST-WEANING PERIOD FOR WILD CHIMPANZEES.

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Chimpanzees (*Pan troglodytes*) are unusual among primates in that most females disperse from their natal community after sexual maturity in a process known to be socially costly. Immigrating females frequently receive aggression from resident females and are socially peripheral despite receiving male support. Previous research indicates that in some populations cortisol levels are elevated in new immigrants but other health consequences of the transfer period and subsequent social isolation have yet to be quantified. Here, I examine 15 years of health records covering two communities of chimpanzees in Gombe National Park, Tanzania to compare frequency of three health symptoms (gastro-intestinal, respiratory and wounding) in immigrant females (n = 13) and newly mature natal females (n = 13). Abnormal health reports were uncommon in this age group and the most frequent health issue was wounding. Immigrant females were significantly more likely to be wounded than natal females ($p = 0.017$). Injuries to the anogenital region were most common and accounted for 38% of all observed wounds. These preliminary data extend findings from multiple sites and show that aggression against immigrants at Gombe also results in a higher frequency of wounding. Reports of gastrointestinal and respiratory disease were too infrequent to analyze statistically but, interestingly, respiratory disease was less common in immigrant females which could be an unintended benefit of their greater degree of social isolation.

Abstract # 217

DENTAL EMERGENCE IN WILD VIRUNGA MOUNTAIN GORILLAS (*GORILLA BERINGEI BERINGEI*) FROM RWANDA

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Dental development provides a basis for assessing maturational status within populations, and correlates with life history across broadly comparative contexts. Current knowledge of great ape dental development is largely based on chimpanzees. However, Virunga mountain gorillas are of particular interest because they are comparatively accelerated in key life history traits, a pattern often attributed to their increased folivory and reduced ecological risk. We assessed gingival tooth emergence in known age Virunga mountain gorillas at the Karisoke Research Center, Rwanda. We made 272 photographic observations of 83 living gorillas (N=51 M, 31 F, 1 unk; 0.0-15.0 years) over three years. Other individuals were assessed at necropsy (N=8) or from skeletons (N=42). Virunga gorillas had completely erupted deciduous dentitions at 1.2 years. Midpoint age at maxillary molar emergence was 3.2 years for M1, 6.7 years for M2, and 10.4 years for M3. One 8.6-year-old individual had erupting mandibular M3s. Midpoint age at maxillary canine emergence was 8.0 and 9.4 years in females and males, respectively. Tooth emergence timing in wild Virunga gorillas overlapped considerably with available data for chimpanzees and western gorillas, but in some respects appeared accelerated as for other life history traits. Ongoing studies are exploring links between tooth emergence, tooth crown and root development, and life history in this population. NSF (BCS 0852866, 0964944, 1520221), NGS (8486-08), The Leakey Foundation, The Wenner Gren Foundation.

Abstract # 219

AN EVOLUTIONARY BASIS FOR VITAMIN D METABOLISM IN THE BABOON, *PAPIO* SPECIES: CAPTIVE AND FERAL

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Vitamin D, an essential vitamin and hormone, is absorbed either through UV radiation or secondarily through dietary sources. Little is known of how it varies in wild primates. We compared vitamin D metabolites in three species of baboons with differences in skin coloration and the density of their pelage. We compared *Papio anubis*, P. cynocephalus and *P. hamadryas* with captive P. anubis from the Southwest National Primate Research Center (SNPRC). Blood samples were analyzed by LC/MS/MS (liquid chromatography/tandem mass spectrometry) using a vitamin D panel. Like other studies of vitamin D3 supplemented captive baboons and macaques, the SNPRC baboons had higher levels of Vitamin D3 (cholecalciferol) than wild African baboons ($t=8.35$, $df=105$, $p<0.0001$). Vitamin D3 levels differed between the wild African species ($F=12, 2, 89$, $P<0.0001$). P. anubis , which has the darkest skin and densest fur, had the lowest Vitamin D3 levels, while hamadryas, with pink face and buttocks and sparse, white fur, had the highest (Tukey's $P<0.05$). Similar results were found for circulating vitamin D3, 25 hydroxyvitamin D3 and intracellular-acting 24,25 dihydroxyvitamin D3. Additionally, there was a within species age effect on their Vitamin D levels. These data suggest that vitamin D3 in baboons is related to differences in the melanin content of skin and the density of fur, providing an adaptive means for regulating vitamin D levels. Funding: NIH P51OD011106, NSF BCS-1029363.

Abstract # 220

VITAMIN D STATUS IN WILD TOQUE MACAQUES (*MACACA SINICA*) IN SRI LANKA

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The vitamin D receptor is found on most cells, implying that vitamin D has important biological functions beyond calcium metabolism and bone health. Although captive primates should be given a dietary source of vitamin D, under free-living conditions vitamin D is not a required nutrient, but rather is produced in skin when exposed to UV-B light. Levels of circulating 25-OH-D sufficient for good health for macaques and other Old World anthropoids are assumed to be the same as human values, but data from free-living animals are scant. This study reports values for 25-OH-D and the active vitamin D metabolite, 1,25-dihydroxyvitamin D (1,25[OH]2 D) for wild toque macaques (*Macaca sinica*) in Sri Lanka. Plasma samples were obtained from 8 adult males, 7 juvenile males, 6 young nulliparous females, 9 adult females not pregnant or lactating, 11

lactating adult females, and 4 pregnant females. Mean values for the complete sample were 61.3±4.0 ng/ml for 25-OH-D and 155.6±8.7 pg/ml for 1,25[OH]2 D. There were no significant differences for either metabolite among age and sex classes, nor between lactating and nonreproductive females. Values from the literature for circulating 25-OH-D in captive macaques are three times higher than those found in this wild population, however, 1,25[OH]2 D values in captive animals were similar to the wild values. Current vitamin D supplementation of captive macaques likely exceeds requirement.

Abstract # 221

NUTRITIONAL STRATEGIES OF FEMALE REDTAIL MONKEYS (CERCOPITHECUS ASCANIUS) IN UGANDA

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Primates consume a combination of available foods in a complex environment to meet their nutritional needs, which change depending on variables like reproductive status. Redtail monkeys, small bodied guenons, rely primarily on fruits and secondarily on insects, leaves, and flowers. The goal of this study was to determine the balance of non-protein energy to available protein in the diets of redtails, and understand their nutritional strategy compared to other primates. We conducted full-day focal follows (n=96) on adult females (n=24) in three groups in Kibale National Park, Uganda and analyzed >402 food samples using wet chemistry and near-infrared spectroscopy. Plant reproductive parts contained a mean of 40.6 ± 16.4 (SD) neutral detergent fiber (NDF), 31.5 ± 15.5 acid detergent fiber (ADF), 15.5 ± 9.6 acid detergent lignin (ADL), 15.8 ± 5.7 crude protein, and 7.6 ± 7.6 fat. In contrast, leaf parts contained a mean of 42.3 ± 8.3 NDF, 28.8 ± 7.5 ADF, 14.6 ± 6.5 ADL, 24.6 ± 5.8 crude protein, and 2.8 ± 0.9 fat; insects contained a mean of 9 ± 2.3 chitin, 68.6 ± 10.6 crude protein and 12 ± 4.5 fat. Preliminary results show that females maintain a NPE:AP balance of 7.8:1 and average daily energy intake of 407 ± 104 kcal, a strategy between that of other frugivores and omnivores studied. Supported by NSF (BCS-1540369, BCS-1521528, BCS-0922709, DGE-0966166).

Abstract # 222

UNPRECEDENTED EUKARYOTIC GUT MICROBIOME DIVERSITY IN MACAQUES (*MACACA FASCICULARIS*) OF SINGAPORE AND BALI, INDONESIA

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The diversity and ecology of symbiotic eukaryotes remain consummately uncharacterized. While previous studies on the associated eukaryotic communities of vertebrates have reported low levels of diversity relative to both sympatric prokaryotic and free-living eukaryotic communities, these findings may be more indicative of differences in the methodologies used to characterize these communities than of ecological differences between these systems. To assess the potential for such hidden diversity within primates, we utilize a novel Illumina sequencing approach to characterize eukaryotic diversity within the feces of wild long-tailed macaques (*Macaca fascicularis*) on two islands in southeast Asia (N=45): Singapore and Bali, Indonesia. We report levels of eukaryotic diversity higher than those previously reported from the feces of primates and comparable to many free-living systems. All five eukaryotic super-groups were represented and several taxonomic groups were found to be common across all samples, suggesting the existence of a core eukaryotic community. Despite these commonalities, differences in eukaryotic gut assemblages were also detected that could be attributed to differences in host geography and diet. All trophic functional guilds (Grazers, Predators, and Intracellular Parasites) were observed, and significant correlations (α=0.05) between functional guilds were concordant with expected trophic interactions. Overall, our findings support a role for non-human primates as reservoirs of microbial eukaryotic diversity, and suggest that primate-associated microbial eukaryotic communities may follow ecological processes similar to those of free-living systems.