PSGB Winter Meeting 2009

1st and 2nd December 2009

Zoological Society of London, Meeting Rooms. ZSL, Regents Park, London.

Meeting Outline

This stimulating meeting will focus on state of the art research pertaining to stress in primates covering behavioural, physiological and neurological responses to stressors in the physical and social environment both in captivity and the wild. The consequences of these responses for the individual's biological fitness will be assessed. The meeting will consist of a number of invited presentations from eminent, international scientists in the field as well as proffered papers spread, in themed sessions, over two days. There will also be one or more poster sessions. We are delighted to announce the conference will feature two plenary presentations and several other invited papers from all from internationally respected researchers.

Call for Early Registration

We are requesting early registrations for this conference. Due to the high interest in this exciting two-day meeting and the limited capacity at the venue we encourage pre-registration to guarantee attendance. Early registrations will be accepted until 17:00 on 29th November 2009 as subject to availability. As the deadline for abstract submission has now past we regret that we are unable to accept abstracts for oral presentations.

Payment Details

The program will commence 09:00 on 1st December and continue until 17:45 on 2nd December. Registration costs include attendance at the two-day meeting and all teas and coffees. Additional details will be posted on the PSGB webpage closer to the date of the conference and e-mailed directly to registrants. We are able to accept payment either online by credit or debit card, or by personnel cheque.

Online payment: You can pay securely online (www.psgb.org/meetings) with a credit or debit card. You will not be charged any fee for using this secure, online payment service.

Cheque: Please make a cheque payable to *Primate Society of Great Britain* and send it, together with a hard copy of the completed registration form (below), to:

Tessa Smith
Department of Biological Sciences
University of Chester
Parkgate Rd
Chester CH1 4BJ.

Alternatively you could send the form online by pressing the 'Submit form only' option.

You will be sent a receipt when payment has been received.

Registration Fees

	Student Member		Student Non-member		Ordinary / Associate Member		Non-member	
	1-Day	2-Days	1-Day	2-Days	1-Day	2-Days	1-Day	2-Days
Cost	£20	£35	£35	£60	£35	£60	£50	£90

Organising Committee

Paul Honess (Oxford University), Stuart Semple (Roehampton University), Tessa Smith (University of Chester)

Provisional Programme

The organisers are please to present the provisional programme for the PSGB Winter Meeting 2009. ***NB. Please note this programme is subject to change.***

1st December 2009

09:00		*Registration*	
09:45		Opening remarks	
10:00	Plenary	**Risk, resilience, and gene x environment interactions in primates**	**Suomi, Stephen**
11:00		*Refreshments & Posters*	
11:30	Invited	**Enrichment, chronic stress and its impact on research data**	**Garner, Joseph**
12:00		Glucocorticoid responses to environmental and social stressors in zoo-housed spider monkeys	Davis, Nick
12:30		The effect of weaning stress on the social behaviour of mountain gorillas	Eckardt, Winnie
13:00		*Napier Medal Presentation, PSGB AGM & Lunch*	
14:30	Invited	**Stress revisited: a critical evaluation of the stress concept**	**Koolhaas, Jaap**
15:00		Ratings of zoo chimpanzees (*Pan troglodytes*) and orangutans (*Pongo pygmaeus* and *Pongo abelii*) are not anthropomorphic projections	Weiss, Alexander
15:30		The influence of visitor density on the behaviour of zoo-housed gorillas (*Gorilla gorilla gorilla*) and chimpanzees (*Pan troglodytes*)	Cooper, Tara
16:00		*Refreshments & Posters*	
16:30	Invited	**Social subordination stress effects behavior, pathophysiology, and disease risk in adult cynomolgus macaques**	**Shively, Carol**
17:00		Stress and attentional bias in rhesus macaques	Bethell, Emily
17:30		Subjective well-being is genetically correlated with personality in orangutans	Adams, Mark
18:00		*Posters & Close*	

2nd December 2009

08:30		*Registration*	
09:20		*Opening remarks*	
09:30	Plenary	**Primate conservation: synergy among stress, nutrition, climate change, & disease**	**Chapman, Colin**
10:30		*Refreshments & Posters*	
11:00	Invited	**The common marmoset: species-typical stress and stress experiments to understand human disorders**	**Pryce, Christopher**

11:30		Sex specific life history and climate related stresses recorded in *Papio hamadryas* dental tissues	Dirks, Wendy
12:00		Impact of human disturbance on stress, disease and conservation of chimpanzees, *Pan troglodytes*, in Budongo Forest, Uganda	Zommers, Zinta
12:30		*Lunch & Posters*	
14:00	Invited	**Distress alleviation in monkeys and apes**	**Aureli, Filippo**
14:30		Individual differences in anxiety level affect reconciliation in wild Japanese macaques (*Macaca fuscata yakui*)	Majolo, Bonaventura
15:00		Social capital and physiological stress in female rhesus macaques	Brent, Lauren
15:30		*Refreshments & Posters*	
16:00		The use of visual barriers to alleviate stress-related hair-pulling in rhesus macaques (*Macaca mulatta*)	Honess, Paul
16:30		Is training for cognitive testing stressful? A comparison of self-directed behaviours of chimpanzees (*Pan troglodytes*)	Herrelko, Elizabeth
17:00		The effects of an enhanced socialisation programme on behaviour, welfare and cardiac responses of newly acquired cynomolgus macaques (*Macaca fascicularis*) during six-week acclimatisation period	Tasker, Louisa
17:30		*Close*	

Posters

Was the primate stress system a selective force for increased hominin intelligence?	Cummins, John
Linear enamel hypoplasias in baboons	Williams, Chris
Integrating measures of behaviour, physical health and physiology to produce an overall assessment of welfare in the cynomolgus macaque (*Macaca fascicularis*)	Tasker, Louisa
Hair loss in captive primates: A long-term four species comparison	Hopper, Lydia
Evidence for differential susceptibility to putative childhood stress effects: The role of relationship status	Boothroyd, Lynda
Investigating the role of social interactions on adrenal activity in female Barbary macaques (*Macaca sylvanus*)	Edwards, Katie
Softly, softly, catchy monkeys	Owen, Yvonne
Victim behaviour following aggression in captive Sulawesi crested macaques	Watkin, Nia
Operant conditioning as a tool for mitigating stress in captive primates	Buckley, Cara
Self-scratching and faecal glucocorticoids as non-invasive measures to assess rank-related social anxiety and stress in wild female Barbary macaques (*Macaca sylvanus*)	Kaburu, Stefano
Grieving monkeys? Self-suckling and infant death in Barbary macaque (*Macaca sylvanus*) mothers	McFarland, Richard

ABSTRACTS – ORAL PRESENTATIONS

1st December

PLENARY LECTURE

RISK, RESILIENCE, AND GENE X ENVIRONMENT INTERACTIONS IN PRIMATES

Stephen J. Suomi
Laboratory of Comparative Ethology, Eunice Kennedy Shriver National Institute of Child Health and Human Development, National Institutes of Health, DHHS, Bethesda, MD 20892-7971, USA
Presenter email: ss148k@nih.gov

Recent research with both humans and rhesus monkeys has provided compelling evidence of gene-environment (G x E) interactions throughout development. For example, a specific polymorphism of the serotonin transporter (5-HTT) gene is associated with deficits in infant neurobehavioral functioning, poor control of aggression and low serotonin metabolism during juvenile and adolescent development, and excessive alcohol consumption in early adulthood in monkeys reared with peers but not in monkeys reared by their mother. One interpretation of these findings is that secure attachment relationships somehow confer resiliency to individuals who carry alleles that may otherwise increase their risk for adverse developmental outcomes ("maternal buffering"). Similar patterns of apparent "buffering" have been demonstrated for G x E interactions involving several other genes with functionally equivalent polymorphisms in both humans and rhesus monkeys. Recent research has suggested that much of this "buffering" may be taking place in the context of early face-to-face interactions between rhesus monkey mothers and their infants. Moreover, the allelic variation seen in these genes in rhesus monkeys and humans but apparently not in other primate species may actually contribute to their remarkable adaptability and resilience at the species level.

INVITED LECTURE

ENRICHMENT, CHRONIC STRESS AND ITS IMPACT ON RESEARCH DATA

Joseph Garner
Animal Sciences, Purdue University, West Lafayette, IN, USA
Presenter email: jgarner@purdue.edu

Behaviour is what makes an animal an animal, and almost every aspect of animals has evolved as a consequence of behaviour: the digestive system is dependent on feeding behaviour; the reproductive system upon mating behaviour; the skelto-muscular system exists to allow locomotive behaviour; even the immune system is intimately interwoven with behaviour. The major role of behaviour is to allow animal to control their environment, and to survive in environments that are physiologically inhospitable, or even lethal. Consequently a lack of control over even innocuous stimuli can induce widespread and devastating stress responses. Biologically relevant enrichments provide animals the mean to control stressors in the environment with suitable species-typical behaviours. Thus properly designed, and experimentally ratified enrichment, should render animals more normal and less variable. Conversely, barren environments, which lack any meaningful control for the animal are likely to induce widespread stress-mediated changes in animals, and such animals will be abnormal and of little relevance as research models. For example, experimental vaccines may be ineffective in barren housing, but extremely effective under enriched conditions, as a product of stress-induced immune suppression in barren housing. As such, the call for enriched housing to show that it is no different from barren housing is nonsensical – instead the burden of proof should be on barren unenriched housing to show that animals housed therein are not abnormal. Using mice as an example, this talk will review these concepts, and illustrate the central role of the animal's natural history, sensory world, and behaviour (the animal's point of view) in designing and validating enrichments. In particular, real world examples will be discussed, where failing to take the animal's point of view has lead to the adoption of 'enrichments' or 'refinements' that actually impair wellbeing; where taking the animal's point of view provides superior solutions to wellbeing issues; and where suitably enriched animals are demonstrably more 'normal' and yield superior research data.

GLUCOCORTICOID RESPONSES TO ENVIRONMENTAL AND SOCIAL STRESSORS IN ZOO-HOUSED SPIDER MONKEYS

Nick Davis[1,2,3], Colleen M. Schaffner[1], Tessa E. Smith[2]
[1]*Department of Psychology, University of Chester, Parkgate Road, Chester, CH1 4BJ,*
[2]*Department of Biology, University of Chester, Parkgate Road, Chester, CH1 4BJ,*
[3]*North of England Zoological Society, Upton-by-Chester, Chester, CH2 1LH*
Presenter email: n.davis@Chesterzoo.org

There is minimal quantitative data on the physiological effects of stressors experienced by zoo-housed primates. Over a 7-year period we monitored the physiological responses to a variety of environmental and social stressors in a group of 8-13 spider monkeys (*Ateles geoffroyi rufiventris*) housed at Chester Zoo. We assessed the impact of visitors, aggression, reproductive events, separation and the introduction of a new male on the spider monkeys' urinary cortisol. We found that cortisol was positively associated with increased visitor numbers. For aggression, reproductive events and separation we investigated the physiological stress responses the week prior, the day of and the week following an event. Aggressive events were associated with the largest increase in urinary cortisol with targets experiencing a seven fold increase in cortisol on the day of severe aggression and bystanders having a 20 fold increase on the day of lethal aggression. In addition, cortisol levels in bystanders were still significantly elevated the week following lethal aggression. For reproductive events, cortisol levels were significantly elevated in mothers the week prior to and the day of birth, and elevated in bystander females on the day of birth. In terms of animal separations, cortisol levels were significantly elevated in separated individuals only when separations were greater than 24 hours. Surprisingly, the introduction of a new male produced little change in urinary cortisol among the resident females. The findings of our study contribute to the understanding of the physiological responses to stressors in a zoo
environment and have implications for animal management.
Keywords: zoos, Ateles*, stress response*

THE EFFECT OF WEANING STRESS ON THE SOCIAL BEHAVIOUR OF MOUNTAIN GORILLAS

W. Eckardt[1,2], A. W. Fletcher[1], K. Fawcett[2]
[1]*University of Chester, UK,* [2]*Karisoke Research Center, Dian Fossey Gorilla Fund International*
Presenter email: w.eckardt@chester.ac.uk

The weaning process in primates can be extremely stressful, in particular for offspring who are weaned at an early age compared to their peers. Infants often respond to weaning with temporary depression and regression to infantile behaviour, such as seeking more contact with the mother and extending the length of suckling bouts. Many studies have investigated behavioural changes in mother-offspring interactions during the course of the weaning process. However, changes in social interactions involving other group members, such as frequency of playing and agonistic behaviour, and the potential long-term impact of these on the offspring's social development have been, in the most part, neglected. In this study, the effect of weaning on the frequency of playful and agonistic behaviour was investigated in 16 mountain gorillas (*Gorilla beringei beringei*) (30-54 months old) living in the Virunga massif (Rwanda). Pre- and post-weaning behaviour were compared within individuals as well as between individuals within the same age range. There was found to be a strong decline in play and an increase in agonistic interactions after weaning, with early-weaned offspring being more strongly affected. In primates, including humans, the combination of a decrease in play behaviour and an increase in agonistic behaviour can be indicative of stress. The potential impact of such behavioural changes on the offspring's social development will be discussed taking the weaning age and sex of offspring into account.
Keywords: weaning stress, wild mountain gorillas, play, agonistic behaviour

INVITED LECTURE

STRESS REVISITED: A CRITICAL EVALUATION OF THE STRESS CONCEPT

Jaap M. Koolhaas
Behavioral Physiology, University of Groningen, P.O.Box 14, 9750 AA Haren, The Netherlands
Presenter email: J.M.Koolhaas@rug.nl

The stress concept has been subject of much scientific debate. This paper will highlight a biologically oriented framework of interpretation to evaluate both the adaptive and maladaptive nature of the stress response in relation to the existing environmental demands. Recent evidence shows that the physiological response to clearly negative, uncontrollable situations may be as large as the response to positive conditions such as food intake or sexual behavior. It will be argued that it is not the magnitude of the physiological response that dissociates a negative from a positive stimulus but the speed of recovery of the response. Stress related terminology should be restricted to uncontrollable and unpredictable conditions. These conditions may lead to a variety of behavioral and neurobiological changes in the organism. To facilitate the interpretation of these stress induced changes in terms of their adaptive and/or maladaptive nature, the concepts of regulatory range and regulatory capacity of allostatic mechanisms will be introduced. These concepts are also helpful in understanding individual differences in coping style and animal welfare in relation to environmental demands. In stress research, much can be gained by more carefully exploiting the biological basis of animals using ecologically relevant models. This allows a fundamental analysis of factors modulating the individual adaptive capacity and hence the individual vulnerability to disease.
Key words: stressor, stress response, adaptation, coping style, allostasis

RATINGS OF ZOO CHIMPANZEES (*PAN TROGLODYTES*) AND ORANGUTANS (*PONGO PYGMAEUS* AND *PONGO ABELII*) ARE NOT ANTHROPOMORPHIC PROJECTIONS

Alexander Weiss[1,2], Mark J. Adams[1]
[1]*Psychology, School of Philosophy, Psychology and Language Sciences, The University of Edinburgh,* [2]*Scottish Primate Research Group*
Email: alex.weiss@ed.ac.uk

If researchers wish to assess subjective states such as stress in animals, they will have to go beyond behavioural measures. These measures might involve hormonal assays whereas others might rely on the judgement or impressions of researchers and personnel who are intimately familiar with the individual animals. Despite findings to the contrary, a major barrier to using the latter is the continuing charge that these types of measures, like so-called subjective personality ratings, are partly or entirely the product of anthropomorphic projection. We will demonstrate two new forms of principal components analysis using existing personality data and test the hypothesis that personality dimensions in nonhuman primates are the products of anthropomorphic projections Subjects were chimpanzees housed in U.S. and Australian zoos (N=202); chimpanzees housed in Japanese zoos, research institutes, and sanctuaries (N=151); and orangutans housed in U.S., Canadian, Australian, and Singaporean zoos (N=174). We show that a) the personality dimensions emerging from the covariance matrix of animal effects do not markedly differ from the dimensions that were described in previous studies and b) the personality dimensions emerging from covariance matrix of rater effects differ somewhat from the animal dimensions. We also show that c) the dimensions emerging from covariance matrix of rater effects differ between the three samples. These findings are contrary to predictions from the hypothesis that ratings are anthropomorphic projections, highlight the ways in which raters perceive personality, and suggest a new method of assessing ratings of personality, stress, and related constructs.
Keywords: personality, chimpanzees, orangutans, anthropomorphism

THE INFLUENCE OF VISITOR DENSITY ON THE BEHAVIOUR OF ZOO-HOUSED GORILLAS (*GORILLA GORILLA GORILLA*) AND CHIMPANZEES (*PAN TROGLODYTES*)

Tara Cooper, Deborah L. Wells, Peter G. Hepper
School of Psychology, Queen's University Belfast, Belfast, BT7 1NN, UK
Presenter email: tjenkins01@qub.ac.uk

Visitors to zoos can influence the behaviour of captive primates, although it is still unclear whether the size of the human audience has an impact upon the welfare of such animals. This study explored the effect of fluctuations in visitor numbers on the behaviour of zoo-housed gorillas and chimpanzees. Chimpanzees (n=6) and gorillas (n=6) housed in Belfast Zoological Gardens were studied during three, 4 day long, periods of visitor density. Period 1 represented a relatively stable phase of visitor density (<2500 people per day). Period 2, which fell over a bank holiday, represented a phase of exceptionally high visitor density (>3000 per day). Visitor

numbers reverted back to relative normality during Period 3 (<2500 per day). The behaviour of all animals was recorded every 5 minutes for 4 hours each day for each period of visitor density using instantaneous scan sampling. Analysis revealed a significant effect of visitor density on the behaviour of both groups, although in different directions. The gorillas spent significantly ($P<0.05$) more time running and less time resting in Period 2 than Periods 1 or 3. The chimpanzees spent significantly ($P<0.05$) less time grooming and more time interacting with visitors in Period 2 than 1 or 3. Both groups spent significantly ($P<0.05$) more time outside, and less time eating and foraging, during Periods 2 than 1 or 3. Results suggest that the behaviour of great apes is influenced by visitor density, but point to species differences in the nature of the effect exerted by the human audience.
Keywords: chimpanzees, gorillas, visitors, zoos

INVITED LECTURE

SOCIAL SUBORDINATION STRESS EFFECTS BEHAVIOR, PATHOPHYSIOLOGY, AND DISEASE RISK IN ADULT CYNOMOLGUS MACAQUES

Carol A. Shively, S.L. Willard, T.B. Clarkson, C.K. Henkel, D.P. Friedman, T.C. Register
Wake Forest University School of Medicine, Winston-Salem, NC, USA
Presenter email: cshively@wfubmc.edu

While there are benefits to social group-living, there are also costs, one of which is the stress that can result from the increased social density and proximity inherent in a gregarious social organization. Social stress may increase the risk of disease, and promote pathophysiological changes that increase the risk of disease. We have studied disease susceptibility in adult female cynomolgus monkeys (*Macaca fascicularis*) housed in small social groups of 4 females each. Linear social status hierarchies form and are stable over long time periods. In order to approximate as closely as possible the human condition, the monkeys are fed a Western diet containing moderate amounts of fat and cholesterol. Socially subordinate females appear behaviorally and physiologically to be stressed relative to dominants. They receive more aggression, are groomed less, spend more time vigilant, less time being groomed, and more time alone than dominants. Subordinates are hypercortisolemic, have higher heart rates in response to a standardized stressor, suppressed reproductive function, and decreased dopamine receptor 2 binding potential in the striatum. They are more likely than dominants to deposit fat in the viscera, develop more coronary artery atherosclerosis, and exhibit depressive behavior. Depressed monkeys are distinct from nondepressed subordinates behaviorally and physiologically. For example, depressed monkeys, like depressed human beings, have alterations in serotonin receptor 1a binding throughout many areas of the brain which mediate emotional responses to environmental events, and smaller anterior hippocampi. Thus, the stress of social subordination in these small captive groups has extensive effects on the behavior, physiology and health of cynomolgus macaques.
Keywords: Stress, cortisol, serotonin, hippocampus, atherosclerosis, visceral obesity, depression

STRESS AND ATTENTIONAL BIAS IN RHESUS MACAQUES

Emily J. Bethell[1,2], Stuart Semple[1], Mandy Holmes[1,2], Ann MacLarnon[1]
[1]Centre for Research in Evolutionary Anthropology, Whitelands College, Roehampton University, Holybourne Avenue, Roehampton, London , SW15 4JD, [2]School of Psychology, Birkbeck College, University of London, Malet Street, London, WC1E 7HX
Presenter email: E.Bethell@Roehampton.ac.uk

Cognitive biases provide a measure of psychological wellbeing in humans. People high in anxiety, for example, demonstrate a bias to attend to threatening information. This is known as attentional bias and is implicated in the onset and maintenance of psychological disorders in humans. Measuring psychological wellbeing in other species has remained problematic for welfare researchers. However, it is possible that the diagnostic and therapeutic cognitive methods used with humans may be adapted for use with other species. We present data from a novel method for testing attentional bias in rhesus macaques. Monkeys were shown pairs of pictures of threatening versus non-threatening conspecific faces. Latency and duration of gaze towards the faces was coded. Following a stressor monkeys showed a different pattern of gaze towards face pairs than when no stressor had been given. We discuss our findings in terms of existing vigilance and avoidance theories of attentional bias for threatening information in

humans, and suggest the method presented provides a valuable means of measuring psychological wellbeing in non-human primates.
Keywords: attentional bias, stress, macaque, psychological wellbeing

SUBJECTIVE WELL-BEING IS GENETICALLY CORRELATED WITH PERSONALITY IN ORANGUTANS

Mark J. Adams[1], Alexander Weiss[1,2]
[1]*Psychology, School of Philosophy, Psychology and Language Sciences, The University of Edinburgh,* [2]*Scottish Primate Research Group*
Presenter email: m.j.adams-2@sms.ed.ac.uk

Subjective well-being, or happiness, captures the balance of positive and negative moods in an individual, and is related to personality, health, and stress responses in humans and other primates. Differences in personality and subjective well-being are described by dimensions that appear to be conserved across primate lineages. To understand the potential for these traits to co-evolve, it is essential to estimate their heritabilities and genetic correlations. Orangutans have been shown to have one well-being dimension in addition to five personality dimensions: Extraversion, Dominance, Neuroticism, Agreeableness, and Intellect. We assessed personality and subjective well-being in 174 zoo-housed orangutans. To reveal the evolvability of personality and subjective well-being in orangutans, we estimated trait heritability simultaneously with a multivariate animal model using Markov chain Monte Carlo. Heritability point estimates for the five personality traits ranged from 0.20 for Extraversion to .43 for Intellect. The heritability of subjective well-being was 0.56. Consistent with findings on humans and chimpanzees, orangutan happiness was genetically correlated with Extraversion (r_A=0.54), Dominance (r_A=0.52), and Neuroticism (r_A=-0.70). Thus, it is possible for genetic differences in well-being to be maintained by correlated responses to selection for personality. These findings suggest the importance of accounting for individual differences in primate personality when assessing the fitness consequences of stress response.
Keywords: Pongo pygmaeus*,* Pongo abelii*, heritability, quantitative genetics*

2nd December

PLENARY LECTURE

PRIMATE CONSERVATION: SYNERGY AMONG STRESS, NUTRITION, CLIMATE CHANGE, AND DISEASE

Colin Chapman
Department of Anthropology and McGill School of Environment, McGill University, Montreal, Quebec, Canada
Presenter email: colin.chapman@mcgill.ca

Tropical countries, many of which harbour primate populations are losing approximately 12.5 million ha of forest annually; these forests are also being degraded by logging and forest fires, which are not considered “deforestation”. In addition to loss of forest habitat primate populations continue to suffer high levels of commercial and subsistence hunting. Thus, the future for primates looks grim without even considering the largely unknown impacts of global climate change and newly emerging infectious diseases, like Ebola. In this talk, we synthesize 26 to 36 years of population and habitat data to determine the potential causes of group density changes for five species of primates in Kibale National Park, Uganda. We focus both on areas within the park that were disturbed in the late 1960s and on forest fragments that lie outside the protected area. Within the national park, mangabey and black-and-white colobus group density increased, blue monkeys declined, while redtails and red colobus were stable in all forest areas. For blue monkeys and mangabeys, there were no significant changes in food availability over time that could account for changes in their group density. For redtails, neither group density nor food availability changed over time. For black-and-white colobus, a decrease in food availability over time in the unlogged forest surprisingly coincided with an increase in group density. Finally, while red colobus food availability and quality increased over time in the heavily logged area, their group density was stable in all areas. In general, all forest fragment populations declined, and this seemed to be a result of a synergy among stress, nutritional, and disease. Analyses of data on disease and cortisol levels suggests that disease levels are increasing as would be predicted based on climate change in the region, and increasing contact

with humans that fosters disease transmission. We suggest that these populations are generally in non-equilibrium states. Thus, large protected areas will be required to ensure that declines in some areas are compensated by increases in areas with different histories.

INVITED LECTURE

THE COMMON MARMOSET: SPECIES-TYPICAL STRESS AND STRESS EXPERIMENTS TO UNDERSTAND HUMAN DISORDERS

Christopher Pryce
Preclinical Laboratory, University Psychiatric Clinic, University of Zurich, Switzerland
Presenter email: christopher.pryce@bli.uzh.ch

Based on over 50 years of study by field and laboratory scientists, the common marmoset (*Callithrix jacchus*) is a primate species for which there is sufficient scientific knowledge to maintain captive groups in species-appropriate i.e. stress-minimizing environments. Only because of this is it possible to have the control conditions against which to study the stress biology of the common marmoset, both in its own right and to provide insights into human stress-related disorders, their mechanisms and treatment. This talk will review studies by my colleagues and I on this species and these subjects. As neonates, common marmosets exhibit high blood basal levels of stress hormones (ACTH, cortisol), and these decline gradually across maturation. Marmoset infants, like human infants, are already able to exhibit stress hormone increases in response to social and physical stressors. Marmoset urinary cortisol titres are positively correlated with blood and CSF cortisol titres, so that urinary cortisol provides a meaningful biomarker for bioactive cortisol availability, both under basal and stress conditions. In stable, intact family groups of marmosets, social stress is minimal. In adult twin sister pairs separated from their parents, agonistic behaviour is rare in the absence of an unrelated male but typical in the presence of an unrelated male. Subordinate sisters either suppress ovulation and avoid aggression or are attacked and ovulation is suppressed: the reduced oestrogen levels of such anovulatory females are associated with reduced cortisol, which therefore does not serve as a stress marker under these social/reproductive conditions. Common marmosets exposed prenatally to high corticoid levels, to model the treatment used in at-risk human premature births, exhibit increased feeding, reduced social play and impaired motor behaviour as they develop. Marmoset infants that are temporarily separated from their parents (early deprivation, ED) but otherwise receive typical parental care, exhibit short-term increases in cortisol and long-term, allostatic increases in blood pressure and noradrenaline. Neither basal nor stress cortisol levels are altered long-term by ED; nonetheless, brain expression of the cortisol receptors is reduced long-term and in the hippocampus specifically. ED marmosets exhibit increased anxiety and depression-like reduced motivation for reward. Human early life stress is also associated with reduced hippocampal cortisol receptor expression as well as increased risk of depression/suicide. Well-designed studies in the common marmoset, that utilise our knowledge of the species to minimise uncontrolled stress, can provide valuable insights into stress-related human disorders, their underlying causes and potential treatments.
Keywords: common marmoset, cortisol, receptors, development, control group

SEX SPECIFIC LIFE HISTORY AND CLIMATE RELATED STRESSES RECORDED IN *PAPIO HAMADRYAS* DENTAL TISSUES

Wendy Dirks[1], Donald J. Reid[1], Louise T. Humphrey[2], M. Christopher Dean[3], Teresa E. Jeffries[4]
[1]*Oral Biology, School of Dental Sciences, Newcastle University, Newcastle upon Tyne,*
[2]*Departments of Palaeontology and* [4]*Mineralogy, Natural History Museum, London,*
[3]*Department of Anatomy and Cell Biology, University College London, London*
Presenter email: Wendy.Dirks@ncl.ac.uk

Teeth develop incrementally, recording the history of their own formation and the chronology of stress episodes in the lives of the individuals in whose mouths they form. In histological tooth sections, daily and longer period incremental lines are visible in dental tissues. Within this regular pattern, stress episodes appear as accentuated lines that can be cross matched between teeth. Our work focuses on using this recorded pattern to compare the ages at which stresses occur in male and female baboons from populations living under different ecological conditions. Our sample consists of pure *Papio hamadryas anubis* and *P. h. hamadryas -anubis* hybrids, with three males and two females from Ethiopia and one male and one female from Uganda. In the Ethiopian female baboons, we compared the ages at stress to rainfall records

from their lifetimes and in the two Ugandan baboons, we compared the ages at stress to the weaning process revealed by spatial changes in strontium/calcium ratio in the enamel. All seven baboons show stresses at the age when their mothers would experience postpartum oestrus, but this occurs at an earlier age in Uganda than in Ethiopia. Females exhibit stress at menarche, while males show stress at the age at which they would disperse from their natal groups. One hybrid male showed more frequent stress than the anubis males, perhaps reflecting less ability to buffer environmental stress with increasing body size during growth. Ethiopian males showed stresses at yearly intervals that seem to correlate with the bimodal pattern of rainfall.
Keywords: baboon, histology, accentuated increments

IMPACT OF HUMAN DISTURBANCE ON STRESS, DISEASE AND CONSERVATION OF CHIMPANZEES, *PAN TROGLODYTES,* IN BUDONGO FOREST, UGANDA
Zinta Zommers[1], Tobias Deschner[2], Fabian Leendertz[3]
[1]Wildlife Conservation Research Unit, University of Oxford, [2]Max Planck Institute for Evolutionary Anthropology, [3]Robert Koch Institute
Presenter email: zinta.zommers@zoo.ox.ac.uk

Across Africa, chimpanzee populations are endangered by habitat loss and hunting. For conservation to succeed, it is critical to determine how chimpanzees adapt to human and environmental stressors. Yet, little is known about the mechanisms by which chimpanzees respond to disturbance. While chimpanzees may adapt to changes through the stress response, chronic elevation of stress hormones may result in reproductive failure and disease. This research project examines the impact of human disturbance on chimpanzees in Budongo Forest, Uganda. It attempts to identify whether human disturbance results in increased stress, and whether or not increase stress influences disease burdens. Between 2006 and 2008, four communities of Budongo chimpanzees, each with different disturbance regimes, were studied. Feces and urine samples were collect opportunistically during focal follows. Behavioural data was also recorded. Over 800 urine samples have been analyzed for cortisol and other stress hormones using Liquid Chromatography-Mass Spectroscopy. Density Gradient Gel Electrophoresis is being used to characterize bacteria assemblages in feces samples to determine if there are differences between individuals in different sites, and between individuals with different levels of stress. By comparing data from the four sites, we will begin to identify the impact of human disturbance on stress and on disease levels in chimpanzees. We expect chimpanzees in disturbed sites to have different bacterial assemblages than chimpanzees in undisturbed sites. Preliminary results indicate that social factors may play a greater role in stress than human disturbance. However analysis is ongoing. Research will increase understanding of wildlife endocrinology and disease ecology.
Keywords: stress, chimpanzee, disease

INVITED LECTURE
DISTRESS ALLEVIATION IN MONKEYS AND APES
Filippo Aureli
Research Centre in Evolutionary Anthropology and Palaeoecology, Liverpool John Moores University, Liverpool, UK
Presenter email: F.Aureli@ljmu.ac.uk

Various measures have been used to quantify stress and related phenomena, such as distress and anxiety, in monkeys and apes. There are physiological measures such as the increase in cortisol and heart rate. Self-directed activities, such as self-scratching and self-grooming, have been successfully used as behavioral indicators. Whereas stress can be an adaptive response preparing an organism for appropriate actions, the prolonged activation of such a response can be deleterious. Thus, mechanisms for alleviating distress are expected to be selected for. The individual perceiving distress may actively seek ways to reduce it. In other cases, third parties may provide distress alleviation. Less is known about these latter mechanisms, but they are particularly interesting for their potential altruistic nature and cognitive underpinnings. For both types of mechanisms it is important not only to describe their potential in distress alleviation, but to fully evaluate their effectiveness.
Keywords: anxiety, self-scratching, grooming, consolation

INDIVIDUAL DIFFERENCES IN ANXIETY LEVEL AFFECT RECONCILIATION IN WILD JAPANESE MACAQUES (*MACACA FUSCATA YAKUI*)

Bonaventura Majolo
Department of Psychology, University of Lincoln, Brayford Pool, Lincoln, LN6 7TS, UK
Presenter email: bmajolo@lincoln.ac.uk

Studies conducted on reconciliation (i.e. the post-conflict exchange of friendly behaviour between former opponents) have mainly investigated intra-individual sources of variation in post-conflict behaviour, showing that animals have a stronger increase in anxiety and are more likely to reconcile after conflicts with valuable partners, such as kin. Much less attention has been given to how differences between individuals in emotional profiles affect post-conflict behaviour. The aim of this study was to analyse whether inter-individual differences in baseline anxiety levels predicted the magnitude of the increase in anxiety following a conflict and the occurrence of reconciliation. Data were collected on two groups of wild Japanese macaques (*Macaca fuscata yakui*). Animals having a higher baseline level of anxiety had a more dramatic anxious response following a conflict while controlling for a series of factors (e.g. relationship quality between opponents). These more anxious animals were also less likely to reconcile than more relaxed individuals. Therefore, more anxious animals face some social costs by being less able to cope with the post-conflict condition. These findings would suggest that inter-individual differences in anxiety levels are somehow maladaptive. However, the results of this study may be interpreted and discussed, following the concept of behavioural syndrome, as tradeoffs between benefits and costs across conditions.
Keywords: competition, emotion, scratching, stress

SOCIAL CAPITAL AND PHYSIOLOGICAL STRESS IN FEMALE RHESUS MACAQUES

Lauren J.N. Brent[1], Stuart Semple[1], Michael Heistermann[2], Ann MacLarnon[1]
[1]*Centre for Research in Evolutionary Anthropology, Roehampton University, London, UK,*
[2]*Department of Reproductive Biology, German Primate Centre, Göttingen, Germany*
Presenter email: L.Brent@roehampton.ac.uk

An emerging body of evidence suggests that social factors influence the stress responses of group-living species. Among those factors, affiliative interactions between individuals and members of their social environment have been linked to stress reduction. Social capital, or the degree to which an individual is integrated into society, represents the constraints and opportunities faced by individuals in their social lives and has been associated with lower stress levels in humans. Social network analysis is a relatively new technique to primatology, but is one that provides a range of measures of social capital which account for both direct and indirect connections between individuals. Here I use social network techniques to explore the relationship between social capital and physiological stress in female rhesus macaques. Behavioural data were collected over a 9 month period for 21 adult females from a free-ranging group on Cayo Santiago (Puerto Rico). Faecal samples were analysed for glucocorticoid metabolite concentrations using enzyme immunoassays and network measures of social capital were generated using UCINET and SOCPROG software. A significant negative relationship was found between one measure of social capital and physiological stress levels, indicating that social capital may help individuals cope with the stressors of group-living. A connection between social capital and stress reduction in female rhesus macaques complements research in human and non-human primates which has shown that greater social capital is associated with improved health, reduced mortality and increased reproductive success.
Keywords: social capital, stress, social network analysis, rhesus macaques

THE USE OF VISUAL BARRIERS TO ALLEVIATE STRESS-RELATED HAIR-PULLING IN RHESUS MACAQUES (*MACACA MULATTA*)

Paul Honess[1], Yingying Jiang[2], Julia McDonnell[2]
[1]*Department of Veterinary Services, University of Oxford, Parks Road, Oxford. OX1 3PT, UK* [2]
Dept of Zoology, University of Oxford, South Parks Road, Oxford, OX1 3PS, UK
Presenter email: paul.honess@vet.ox.ac.uk

Captive conditions place a number of stresses on captive primates. One of the manifestations of this, among macaques held for biomedical research, can be diffuse or localised alopecia resulting from abnormal hair-pulling behaviour. While alopecia can result from a number of non-behavioural causes, it is the association with stress-related behaviour which is attracting the attention of regulators, veterinary surgeons and primate welfare biologists, as it may provide a practical index of stress. A number of foraging and grooming-related enrichment studies have shown a degree of success in reducing hair-pulling behaviour. This presentation describes a study examining the effect of an increase in the provision of visual barriers on hair-pulling among twenty-five group-housed rhesus macaques (*Macaca mulatta*) in a breeding facility in the UK. The introduction of extra visual barriers produced a significant reduction in hair-pulling behaviour, but also had other beneficial effects: significantly decreasing aggression and significantly increasing both affiliative behaviour and the amount of time spent foraging. This study demonstrates that this simple and relatively cheap environmental enrichment option not only has a dramatic effect on hair-pulling behaviour but also has significant benefits for other aspects of animal welfare.
Keywords: hair-pulling, alopecia, stress, visual barriers

IS TRAINING FOR COGNITIVE TESTING STRESSFUL? A COMPARISON OF SELF-DIRECTED BEHAVIOURS OF CHIMPANZEES (*PAN TROGLODYTES*)
Elizabeth S. Herrelko, Sarah-Jane Vick, & Hannah M. Buchanan-Smith
Department of Psychology, University of Stirling, UK
Presenter email: bherrelko@gmail.com

An important aspect of research with animals is ensuring the study is as stress-free as possible for both the welfare of the animals and the quality of the research. As with many cognitive studies, the ChimpCam Project, an examination of chimpanzee (*Pan troglodytes*) cognition with the use of cameras and computer tests, needed to start out with training. The goal of this study was to identify whether or not training for cognitive testing elicited higher rates of self-directed behaviours (SDBs) when compared to other activities, as expected if the chimpanzees were anxious, uncertain or frustrated by the training. SDBs of 11 chimpanzees (6 males, 5 females) collected during a five-month period were compared between conditions: (1) baseline (non-training situations) and two training conditions (2) an ongoing, two-year programme of husbandry training (off-exhibit, i.e. station/stay while being closed into an area) and (3) training for cognitive testing (i.e. introducing new on-exhibit areas and targeting to test windows). Preliminary findings indicate that the mean rate per minute of SDBs during training for cognitive tasks did not differ from husbandry training, nor did SDBs during overall training differ from those exhibited during activities outside training. There was considerable individual variation in rates of SBDs that are not easily explained by level of training nor willingness to participate. We conclude that training chimpanzees for husbandry and for cognitive tests does not compromise welfare, but rather that their repeated interest in the challenges offered, and their willingness to participate, implies that the training is enriching and mentally stimulating.
Keywords: cognition, training, self-directed behaviours, welfare

THE EFFECTS OF AN ENHANCED SOCIALISATION PROGRAMME ON BEHAVIOUR, WELFARE AND CARDIAC RESPONSES OF NEWLY ACQUIRED CYNOMOLGUS MACAQUES (*MACACA FASCICULARIS*) DURING SIX-WEEK ACCLIMATISATION PERIOD
Lou Tasker[1], Janet Kelly[2], Simon Sutcliffe[2], Hannah M. Buchanan-Smith[1]
[1]Department of Psychology, University of Stirling, UK, [2]Covance Laboratories Ltd, Otley Road, Harrogate, North Yorkshire, UK
Presenter email: Louisa.Tasker@stir.ac.uk

Non-human primates may instinctively perceive humans as a threat, reacting fearfully or aggressively when in close proximity. Humans are, however, a necessary feature of the lives of all captive animals, and close contact (including visual, auditory, olfactory stimuli) and handling is often regularly required in laboratories. Animal care guidelines recommend positive staff-animal relationships to enhance primate welfare. Habituating and socialising primates to the behaviour, sight, sound and smell of humans, will help to avoid or reduce fear responses and facilitate handling for routine husbandry such as weighing and physical examination. Our aim was to determine the effects of a six-week enhanced socialisation programme with animal care staff on newly acquired cynomolgus macaques (*Macaca fascicularis*) in a laboratory. We

compare a range of welfare measures recorded from control (N=40) and a matched group (N=40) of male and female juvenile macaques subject to a socialisation programme based upon pairing care staff contact and routine events with food rewards e.g. small pieces of dried fruit. We compare data between the two groups on the behavioural responses to care staff during handling and husbandry, changes in body weight, body condition and alopecia scores, and physical health over six weeks from arrival at a new facility. We also investigate the effects of socialisation on cardiac parameters (heart rate, electrocardiogram waveforms and blood pressure) recorded at baseline by non-invasive digital electrocardiogram (ECG) and in-direct high definition oscillometry blood pressure. Our results provide support for the importance of positive relationships for both primate welfare and quality of science.
Keywords: cynomolgus macaque, welfare, socialisation, refinement

ABSTRACTS – POSTER PRESENTATIONS

WAS THE PRIMATE STRESS SYSTEM A SELECTIVE FORCE FOR INCREASED HOMININ INTELLIGENCE?

John Cummins
Presenter email: deva_research@lineone.net

The evolution of primate intelligence likely led to increased episodes of chronic psychological stress, as individuals lived less 'in the moment' and were able to prospect about future outcomes. The increase in psychological stress impacts adversely on physical health, longevity and reproductive fitness, i.e., allostatic load, potentially leading to an evolutionary bottleneck, limiting the evolution of intelligence, unless resolved through a selective mechanism. A cognitive framework involving an increased interrelationship between the primate stress system and hominin intelligence is proposed. Non-human primates may have a high-level, late-stage comparator, receiving input from many specialised parallel modules. Operating serially, it accurately compares actual and goal states to assess the animal's effectiveness. It sends a record of effectiveness to long-term memory, and corrective feedback to the specialist modules. It also sends excitatory and inhibitory signals to the stress system. I propose a chance variation in hominins, raising the threshold of excitation of the stress system along these pathways, with feedback causing the comparator to assess that the animal is more in control of the situation than is accurate. This potentially dangerous event was not 'washed out' through learning, but caused far-reaching systemic effects. It introduced flexibility to the comparator and enabled it to model a variety of relationships between goal and actual states, representing real or illusory control, creating domain –general intelligence. Flexibility was also 'sucked down' differentially by the specialist modules according to their ecological requirements, leading to increased domain-specific intelligence. Flexible syntax in the language module is offered as an example.
Keywords: primate, Hominin, stress, intelligence

LINEAR ENAMEL HYPOPLASIAS IN BABOONS

Chris Williams
Department of Archaeology, University of Sheffield, S1 4ET, UK
Presenter email: prp06cjw@sheffield.ac.uk

Linear enamel hypoplasias (LEH) are enamel defects that provide a record of periods of physiological stress on tooth formation. This study uses macroscopic and microscopic methods to analyze the expression of LEH in baboons (subspecies of *Papio hamadryas*). The study sample consists of 85 wild baboon specimens from the collection at the Royal College of Surgeons, London. Only permanent teeth with an estimated 80% of crown height present with perikymata visible over much of the enamel surface were included. The frequencies of LEH were analysed for both individuals and tooth class by sex and jaw. No significant difference was found between males and females in the frequency and distribution of LEH defects. The mandibular dentition (20% of teeth affected) exhibited more defects than the maxillary dentition (11.5%). I1s and I2s were found to have the highest frequencies of LEH (48.8% and 25.4%, respectively, across both jaws). A subsample of 16 mandibular incisors exhibiting LEH was selected for microscopic analysis. Tooth impressions were sputter-coated and viewed under reflected-light microscopy. Defect width, the distance of the defect from the cementum-enamel junction (CEJ) and the number of perikymata within the defect were recorded. The majority of

the LEH were located in the cervical third of the tooth crown. Defect widths ranged from 140 to 990µm (mean=470µm), containing between 2-8 perikymata (mean=4.8). The results of the analyses were compared with available published data for other non-human primates in order to assess the effect of dental development patterns on the expression of LEH.
Keywords: enamel hypoplasia, dental defect, developmental stress, baboons

INTEGRATING MEASURES OF BEHAVIOUR, PHYSICAL HEALTH AND PHYSIOLOGY TO PRODUCE AN OVERALL ASSESSMENT OF WELFARE IN THE CYNOMOLGUS MACAQUE (*MACACA FASCICULARIS*)

Lou Tasker[1*], Janet Kelly[2], Hannah M. Buchanan-Smith[1]
[1]*Department of Psychology, University of Stirling, UK,* [2]*Covance Laboratories Ltd, Otley Road, Harrogate, North Yorkshire, UK*
Presenter email: Louisa.Tasker@stir.ac.uk

Care staff need to assess primate wellbeing accurately in order to promote refinements and to ensure any changes made to the environment, husbandry or procedures are appropriate in promoting positive welfare, for example through enrichment, and by preventing or minimising stress. This is no easy task as there are species and individual differences in response to environments. Furthermore welfare is a complex state and no single measure of it is universally accepted. In this presentation we outline the development and use of a multi-dimensional welfare assessment for cynomolgus macaques (*Macaca fascicularis*); the most frequently used non-human primate in laboratories. Our aim was to construct an assessment framework that could be used to evaluate the effectiveness of planned changes to husbandry events. We built upon current laboratory assessments for animal well-being, using a stepwise rationale for inclusion of multiple species-specific measures based upon their feasibility, validity, reliability and sensitivity to detect changes in welfare status. We review behavioural, physiological and physical health data from 10 cohorts of group-housed male and female juvenile macaques (N=350) subject to normal housing and husbandry procedures in the laboratory. We advocate using a range of welfare measures to provide care staff with a surveillance framework for monitoring the well-being of cynomolgus macaques. This framework is being used successfully to assess targeted changes to routine handling and husbandry, ensuring they effectively enhance macaque quality of life.
Keywords: cynomolgus macaque, welfare, integrating measures

HAIR LOSS IN CAPTIVE PRIMATES: A LONG-TERM FOUR SPECIES COMPARISON

Lydia M. Hopper[1], Susan P. Lambeth[2], Mary Owens[2], Ty McAdams[2], Ricky Merino[2], Leigh Ann Long[2], Lawrence E. Williams[2], Steven J. Schapiro[2]
[1]*Department of Anthropology, South Road, Durham University, Durham, DH1 3LE, UK,*
[2]*Department of Veterinary Sciences, The Michale E. Keeling Center for Comparative Medicine and Research, The University of Texas M.D. Anderson Cancer Center, Bastrop, Texas, USA*
Presenter email: lydia.hopper@durham.ac.uk

We report the current status of a long-term assessment of hair-pulling behaviours by chimpanzees (*Pan troglodytes*), rhesus macaques (*Macaca mulatta*), squirrel monkeys (*Saimiri boliviensis boliviensis, S. b. peruviensis* and *S. sciureus*), and owl monkeys (*Aotus nancymaae*, *A. azarae*, *A. vociferans*) housed at The Michale E. Keeling Center for Comparative Medicine and Research (KCCMR), The University of Texas M.D. Anderson Cancer Center, USA. There are many hypotheses surrounding hair loss in primates, with potential causes related to hormone changes, stress, seasonal changes, housing, breeding, aggression, sex and age. A recent review concluded that it is a maladaptive behaviour, most likely related to chronic stress-related husbandry deficiencies; the Institute for Laboratory Animal Research associated hair-pulling with chronic exposure to environmental stressors. Our on-going study aims to rate primate hair loss at KCCMR quarterly for a minimum of 2 years. This regular data collection will (i) allow for the analysis of baseline hair loss, (ii) identify possible risk factors and, in the future, (iii) assess the ameliorating effects of novel environmental enrichment. Hair loss is scored using a random sample of no less than15% of each species within our primate population (chimpanzees N=29, rhesus moneys N=151, squirrel monkeys N=61, and owl monkeys N=36). A total of 277 primates were randomly sampled to guarantee the inclusion of adult males, adult females, adolescent males and adolescent females. For each species we consider ‘season’ (spring/summer/fall/winter), ‘sex’ (male/female), ‘age’ (adult/subadult) and ‘group size’ as

correlates for hair pulling levels. *Keywords: hair loss, chimpanzees, rhesus macaques, squirrel monkeys, owl monkeys*

EVIDENCE FOR DIFFERENTIAL SUSCEPTIBILITY TO PUTATIVE CHILDHOOD STRESS EFFECTS: THE ROLE OF RELATIONSHIP STATUS

Lynda G. Boothroyd[1], David I. Perrett
[1]*Department of Psychology, Durham University, UK,* [2]*School of Psychology, University of St Andrews, UK*
Presenter email: l.g.boothroyd@dur.ac.uk

Father absence and family stress have long been associated with age of menarche and it has previously been reported (Boothroyd & Perrett 2008: study 1) that there is also an association between family background and facial attraction. In the current study however, childhood stress in the form of father absence or a poor father-daughter relationship were associated with a difference in facial preferences and age of menarche only amongst those who were single or in unhappy/uncommitted relationships. Those who reported that they were in happy and committed relationships showed no difference between father absent and present individuals in terms of either current facial preferences or past pubertal development. Thus tendency to be in a positive relationship in adulthood seems to indicate some critical difference between subgroups of father absent/high stress women. This further supports the notion (proposed by, e.g., Belsky 1997) that some individuals may be more susceptible to the "effects" of rearing environment than others.
Keywords: menarche, Homo sapiens, *father absence, mate choice*

INVESTIGATING THE ROLE OF SOCIAL INTERACTIONS ON ADRENAL ACTIVITY IN FEMALE BARBARY MACAQUES (*MACACA SYLVANUS*)

Katie L. Edwards[1,2], Susan L. Walker[2], Rebecca Bodenham[1], Susanne Shultz[1,3]
[1]*School of Biological Sciences, University of Liverpool, Liverpool, UK,* [2]*North of England Zoological Society, Chester Zoo, Chester, UK,* [3]*Institute of Cognitive and Evolutionary Anthropology, Oxford University, Oxford, UK*
Presenter email: K.L.Edwards@liverpool.ac.uk

Activation of the Hypothalamic-Pituitary-Adrenal (HPA) axis and the subsequent release of glucocorticoids from the adrenal gland allows individuals to adapt to changes in their environment. Although this process is part of the body's normal response to a stressor, prolonged elevation of glucocorticoids can have deleterious effects on a wide range of processes including health and reproduction. In primates, social stressors may be one way in which adrenal activity is increased, but social systems are complex and the relationship between dominance rank and glucocorticoid concentration across species is not consistent. Previous studies have used average glucocorticoid concentrations to draw links between either dominance rank or particular social behaviours and adrenal activity. However, hormone concentrations are transient, and this approach could be misleading. We hypothesise that adrenal activity is dependant on the individual, and related to the specific behaviours in which that individual is involved. In the current study, eight female semi-free ranging Barbary macaques (*Macaca sylvanus*) at Trentham Monkey Forest (Staffordshire, UK) were followed for consecutive days, so that observed rates of social behaviours could be analysed in respect to the glucocorticoid concentration present in faeces the following day. Data were analysed in two ways, 1) assessing the relationship between average glucocorticoid concentrations and average rates of particular behaviours, and 2) analysing daily glucocorticoid concentrations within individuals in relation to specific social behaviours. By comparing the outcome of these analyses, it is clear that the influence of behaviour on adrenal activity is complex, and determining what factors predict adrenal activity can vary depending on the analysis employed.
Keywords: glucocorticoids, behaviour, primates, Macaca

SOFTLY, SOFTLY, CATCHY MONKEYS

Yvonne Owen
Writtle College, UK
Presenter email: Yvonne.owen@ntlworld.com / 98272056@writtle.ac.uk

Traditional techniques used to capture New World monkeys, such as net captures, can induce high levels of acute stress resulting in physiological and behavioural responses detrimental to welfare. Alternatively, training animals to voluntarily participate in husbandry and/or veterinary practices using operant conditioning via positive reinforcement training is accepted as a humane process which can reduce stress and improve welfare. A practical application for training red-bellied tamarins (*S. labiatus*) had been identified within Paradise Wildlife Park (Hertfordshire, UK). This case study aimed to establish whether it was possible to use operant conditioning to train a family of five red-bellied tamarins to voluntarily enter a transportation box and remain calm for one minute, and whether this technique could be used to reduce their experience of stress during capture and containment. A study of two separate net capture processes was conducted and measures of locomotion and vocalisations were recorded and compared to the same measures recorded during the capture of the trained tamarins. Although analysing stress-induced vocalisations as a quantitative measure of stress has been studied in rodents and farm animals this measure remains relatively novel. Net-captured monkeys exhibited rapid and erratic locomotion and emitted long, sustained and high frequency vocalisations during capture, whereas the trained tamarins exhibited minimal locomotion and emitted only four brief vocalisations at RMS -35 dB during capture. This study indicates that the use of operant conditioning via positive reinforcement training did reduce potential for stress and improve welfare during the capture and containment of the study group.
Keywords: stress, welfare, transportation, operant conditioning

VICTIM BEHAVIOUR FOLLOWING AGGRESSION IN CAPTIVE SULAWESI CRESTED MACAQUES
Nia Watkin, Sean J. O'Hara
School of Biological Sciences, University of Liverpool, UK
Presenter email: n.watkin@me.com; sean.ohara@liv.ac.uk

Primates have complex social groups compared with most other non-human mammals. There are many benefits associated with group living but there are also associated costs. Most of these costs relate to conflicts of interest or compromises, for example, over direction of travel or time scheduling. Disputes, erupting as a result of within-group competition, are the most serious form of internal conflict as they can lead to aggression between group-mates causing injury, stress and damage to social relationships. A key question in understanding social evolution is how do victims of aggression deal with the negative consequences of group living? We evaluated this by measuring post-conflict behaviour in a group of 31 captive Sulawesi macaques (*Macaca nigra)* at Chester Zoo. Our results showed victims, but not their aggressor, increased their level of group monitoring, self-scratching, lick-smacking, teeth-baring and vocalisation compared to matched-control periods. They played and foraged less. In addition, victims received increased lip-smacking, vocalisation and aggression from group-mates who also groomed and played with victims less than during matched-control periods. However, compared to their aggressor, victims engaged in more post-conflict affiliative interactions (e.g. embraces, allogrooming). Given the suite of behaviours suggesting foraging and other beneficial activities are tempered while the victim anticipates further attack we interpret these findings as evidence that aggression is costly and stressful for victims. Post-conflict affiliative interactions, however, appear to mitigate this negative aspect of group living for victims.
Keywords: affiliation, post-conflict, stress, victim

OPERANT CONDITIONING AS A TOOL FOR MITIGATING STRESS IN CAPTIVE PRIMATES
Cara Buckley, Holly Barnes, Kate Diver
Monkey World Ape Rescue Centre, Wareham, Dorset, UK
Presenter email: carabuckley123@hotmail.com or cara@monkeyworld.org

Operant conditioning can be defined as the 'reinforcement of conscious behaviour deliberately offered by the learner'. This method, commonly referred to as 'clicker training', is used in captive situations to facilitate health and behavioural management. Monkey World has spent several years developing a comprehensive operant conditioning programme for all of their residents, from the great apes to the marmosets. As an organisation, Monkey World rescues primates who have often suffered abuse at the hands of their human carers. A key part of their rehabilitation involves pairing/grouping with other conspecifics. To facilitate this, we developed minimal-

contact, low stress management while at the same time building trust between primates and staff, allowing close observation and solutions to health, nutritional and social issues. Three key aims of our operant conditioning programme are to weigh, crate and sedate animals with little to no stress. Socially, operant conditioning allows us to shift, separate and reunite animals in a way that is conducive to group cohesiveness and positive group dynamics. It has also allowed us to develop routines where all our primates are released from their indoor to outdoor enclosures individually. Nutritionally, this provides staff with the opportunity to supplementary feed any animals that are underweight, medicate as required and perform daily visual health examinations. Many of the primates are also desensitised to props such as scales, stethoscopes, ear thermometers, topical lotions and swabs, allowing further investigation of health issues without the need for anaesthetic. When anaesthetics are unavoidable, many of our smaller primates are trained to enter crates, while our apes take voluntary hand injections. All these techniques are specifically designed to minimise potential stress and stressful situations for the primates in our care.
Keywords: operant conditioning, stress, health and behavioural management

SELF-SCRATCHING AND FAECAL GLUCOCORTICOIDS AS NON-INVASIVE MEASURES TO ASSESS RANK-RELATED SOCIAL ANXIETY AND STRESS IN WILD FEMALE BARBARY MACAQUES (*MACACA SYLVANUS*)

Stefano S.K. Kaburu[1], Stuart Semple[1], Bonaventura Majolo[2], Mohammed Qarro[3], Ann MacLarnon[1]
[1] Centre for Research in Evolutionary Anthropology, School of Human and Life Sciences, Roehampton University, Holybourne Avenue, London SW15 4JD, UK. [2]School of Psychology, University of Lincoln, Brayford Pool, Lincoln LN6 7TS, UK. [3]Ecole Nationale Forestiére d'Ingénieurs. Avenue Moulay Yousseff, BP 511, Tabriquet, 1100 Salé, 12 Morocco
Presenter email : sskk2@kent.ac.uk

This study investigated rank-related correlates of anxiety and stress, and the relationship between these two states, in wild female Barbary macaques living in the Middle Atlas Mountains, Morocco. Researchers have employed both behavioural and physiological measures to assess non-invasively the social and environmental factors that induce anxiety and stress in animals. At the behavioural level, self-directed behaviours (SDBs), such as self-scratching, are generally associated with an anxious emotional state, which may result from uncertain and unpredictable situations animals experience; the non-invasive physiological indices used to measure stress most often rely on the extraction and assessment of faecal glucocorticoids (FGCs). Although many studies have focused on either SDBs or FGCs, few have investigated both measures simultaneously. In the present study, lower-ranking females exhibited significantly higher rates of self-scratching than dominants, probably because the continual attempts by dominants to assert their dominance status over subordinates provoke anxiety in the latter individuals. By contrast, higher-ranking females showed significantly higher FGCs than low ranking females in the pre-partum period, implying that they may experience more sustained stress than subordinates. Moreover, there was no correlation between self-scratching rates and FGCs. These results add to previous work showing that SDBs and FGCs are not interchangeable measures, and highlight the value of quantifying both behavioural and physiological indices within the same study.
Keywords: stress, anxiety, rank, Barbary macaque, glucocorticoids

GRIEVING MONKEYS? SELF-SUCKLING AND INFANT DEATH IN BARBARY MACAQUE (*MACACA SYLVANUS*) MOTHERS

Richard McFarland, Bonaventura Majolo
School of Psychology, University of Lincoln, Brayford Pool, Lincoln, LN6 7TS, UK
Presenter email: rmcfarland@lincoln.ac.uk

We analysed the relationship between self-suckling and infant death in wild female Barbary macaques (*Macaca sylvanus*) in the Middle-Atlas Mountains, Morocco. Four females, from two troops, experienced the death of an infant due to predation or unknown causes. In one troop, self-suckling was observed before and after the death of an infant. Initially, short events of self-suckling were observed during breastfeeding. These were interpreted as a way of improving milk flow when the infant switched from one nipple to the other. Following the death of an infant, self-suckling lasted significantly longer and females appeared to be drinking their own milk. Self-

suckling was only observed in one of the two study troops. This could therefore represent cultural differences in the expression of this behaviour. Self-suckling after the death of an infant might be explained by the possible energetic and immunological benefits that a monkey would re-gain from drinking her own milk, and/or it might serve as a pain- release mechanism for engorged breasts. The most intriguing explanation, however, views self-suckling as functioning to release stress in mothers who have suffered the death of an infant. Such a calming effect may be explained through the release of prolactin due to suckling from the nipple.
Keywords: culture; emotion; grief; lactation; maternal behavior; stress

Primate Society of Great Britain

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