Institution: University of Portsmouth

Unit of Assessment: 4 Psychology, Psychiatry and Neuroscience

Title of case study: Improving public engagement with and understanding of science through a zoo-based primate research facility

1. Summary of the impact

We have established a primate research centre (The Macaque Study Centre) in a zoo environment (Marwell Zoo) for research into primate social cognition. Visitors can watch the science taking place, which 1) significantly increases their perception of the zoo as a place of learning, 2) increases their knowledge about the specific research being conducted, and 3) improves children's attitudes to science as an exciting subject. Marwell Zoo integrate the research into their educational workshops, and similar facilities are now being established in other zoos in light of the demonstrable scientific, public engagement/involvement and animal welfare benefits.

2. Underpinning research

The underpinning research summarised here was carried out under the leadership of Dr Bridget Waller (Reader in Evolutionary Psychology, University of Portsmouth, during the period 2006-2013) who established the Macaque Study Centre (MSC) in 2011. Key academic co-investigators include: Professor Kim Bard (1999 to present) and Dr Jerome Micheletta (Lecturer from 2012).

Comparative cognitive research is crucial to elucidate the evolutionary origins of human communication. Waller and Bard conducted seminal studies comparing human facial expression with chimpanzee facial expression, and found that the anatomical basis of similar expressions is almost identical [1], providing strong support for the argument that human facial expressions derive from a common primate ancestor. Waller went on to develop standardised, anatomically informed stimuli to conduct comparative cognitive experiments with chimpanzees, demonstrating that human face processing is rooted in ancestral systems [2]. Waller has also used an evolutionary approach to develop a novel explanation for the enormous variation found in human facial muscles – that muscles necessary for basic facial expressions are universal, but muscles underlying more idiosyncratic movements are not [3]. Most recently, Waller collaborated with scientists who study other modalities (vocalisations and gesture) to develop a new theory about the importance of multimodality in the evolution of human language [4].

The MSC is a new facility where research is taking place with public involvement from the outset: even very recent findings have had an educational impact on the public as they have witnessed the process from data collection right through to the first dissemination of findings (via educational materials and talks at the zoo). Research has been supported through basic sciences funding (grants 1 and 2) but also through public engagement with science schemes given the potential for public participation during data collection (grant 3). The MSC is the first facility for cognitive research with crested macaques (*Macaca nigra*) in the world. The vast majority of comparative cognition research takes place in laboratory environments, but our facility is situated in a socially-housed zoo group and all research takes place on public view. The animals voluntarily enter an individual testing room and work with a researcher on cognitive tasks via a computerised touchscreen. The first data resulting from the MSC was published in 2012, which demonstrated that crested macaques follow the gaze direction of their conspecifics - a key developmental stepping stone toward complex traits such as theory of mind [5]. Interestingly, the macaques followed the gaze of their friends (individuals with which they have long-term social bonds) more quickly than non-friends, suggesting that the way in which primates communicate is not automated and reflexive, but instead responsive to the specific relationship between individuals. We conducted a similar experiment in the wild showing that crested macaques respond more to the recruitment alarm calls of their friends than non-friends [6] and may be more likely to assist friends in chasing off a predator. Both findings add to the growing body of evidence that aspects of complex human communication can be traced back to our primate ancestors.

3. References to the research

1. Waller, B.M., Vick, S.J., Parr, L.A., Bard, K.A., Smith Pasqualini, M.C., Gothard, K. & Fuglevand, A. (2006). Intramuscular stimulation of facial muscles in humans and chimpanzees: Duchenne revisited. *Emotion, 6(3)*, 367-382. DOI: 10.1038/1528-3542.6.3.367 (IF = 3.3, cited 27 times). This study was the first to compare the functional morphology of facial muscles between humans and another primate, and set the scene for the development of ChimpFACS (a systematic anatomically based coding scheme to compare chimpanzee and human facial expressions). Following this example, similar systems have now been developed for use with many other animal species.
2. Parr, L.A., **Waller, B.M.** & Heintz, M. (2008). Facial expression categorization by chimpanzees using standardized stimuli. *Emotion*, 8(2), 216-231. DOI: 10.1037/1528-3542.8.2.216 (IF = 3.3, cited 18 times, top 25% for citations in subject field psychology). This study was the first to use standardised stimuli (developed using ChimpFACS) in facial expression categorisation tasks by chimpanzees, which allowed us to probe the mechanisms underlying chimpanzee's face processing skills in hitherto unavailable detail. The findings showed that, like humans, chimpanzees rely on both featural and configural cues to discriminate between conspecific facial expressions. REF 2 output: 4-BW-002
3. Waller, B.M., Cray, J.J. & Burrows, A.M. (2008). Selection for universal facial emotion. *Emotion, 8(3)*, 435-439. DOI: 10.1037/1528-3542.8.3.435 (IF = 3.3, cited 23 times, top 10% for citations in subject field psychology). Here, we conducted dissections to explore the individual variation present in human facial muscles. Muscle necessary for universal facial expressions did not exhibit the same variation as other facial muscles, which helps explain a long debated conflict between the psychological and anatomical literature – that humans have different facial muscles but can still produce universal facial expressions. REF 2 output: 4-BW-001
4. Slocombe, K.E., Waller, B.M. & Liebal, K. (2011). The language void: The need for multimodality in primate communication research. *Animal Behaviour*, *81(5),* 919-924. DOI: 10.1016/j.anbehav.2011.02.002 (IF = 3.5, cited 16 times, top 1% for citations in subject field psychology). This study was the first to quantify how methods vary in primate communication research depending on the modality under study, and that theories of language evolution are flawed as a result. We propose a multimodal approach to primate communication and language evolution instead. REF 2 output: 4-BW-004
5. Micheletta, J. & Waller, B.M. (2012). Friendship affects gaze following in a tolerant species of macaque (Macaca nigra). ***Animal Behaviour*, *83(2),* 459-467.** DOI: 10.1016/j.anbehav.2011.11.018 (IF = 3.1, cited 3 times). This study was the first to demonstrate that the strength of social bond affects the speed at which primates follow one another's gaze direction, a useful cue to important things in the environment. The data contribute to the growing body of evidence that 'friendship' is a genuine concept in animal societies, and likely had an important impact in the evolution of primate societies.
6. Micheletta, J., Waller, B.M., Panggur, M.R., Neumann, C., Dubosq, J., Agil, M. & Engelhardt, A. (2012). Social bonds affect anti-predator behaviour in a tolerant species of macaque, *Macaca nigra. Proceedings of the Royal Society: B Series.* DOI: 10.1098/rspb.2012.1470 (IF = 5.7, cited 3 times). Here, we show that macaques respond more strongly to recruitment alarm calls when they are produced by their 'friends', suggesting that friendship can provide a significant survival advantage (even in life-threatening social contexts).

Grants sponsoring the research:

1. The Leverhulme Trust, Research Interchange Grant entitled "Chimpanzee Emotions: Development of a facial action coding system" to Kim Bard, Lisa Parr and Marcia Smith Pasqualini 2002-2005, (£128,031)
2. Leakey Foundation Research Grant 'Adaptive function of facial displays in crested macaques (*Macaca nigra*)' to Bridget Waller and Jerome Micheletta, 2013-2014, $20,884
3. British Psychological Society Public Engagement Grant 'Development and evaluation of interactive exhibits promoting comparative psychology in a zoo environment' to Katie Slocombe and Bridget Waller, 2012-2013, £19,340

4. Details of the impact

The MSC is a collaborative project with Marwell Wildlife (the charity managing Marwell Zoo) who are committed to the educational and scientific outcomes of the project [1] and advertise the project via their website [6]. Marwell Zoo receives approximately 500000 visits per annum, of which approximately 36000 visit the MSC. Visitors are from a broad cross-section of socio-economic backgrounds and ages (approximately 10% under 21yrs old [7]) many coming from groups difficult to engage in science communication through other means. Visitors can watch the scientists working with the macaques through a viewing window, and engage with information materials surrounding the MSC (developed with Marwell education team). The materials explain specific research findings plus background information. For example, there is an interactive facial expression sign that invites visitors to guess the 'meaning' of each facial expression (relating directly to our comparative facial expression research). The Marwell education team integrate the research into their educational workshops through interactive tasks based on our experiments with the macaques [2].

Public understanding and engagement has improved as a result of our research. We assessed visitor knowledge and attitudes and visitor behaviour systematically. We compared visitors on days when the scientist was present, with visitors on days when the scientist was not present, and also compared those who read the signs with those who did not. First, visitors perceived greater learning when the scientist was present, suggesting that the presence of the scientist affected how much people felt they could (and did) learn from the experience. Second, visitors exhibited more positive attitudes to science and conservation when the scientist was present, suggesting that the scientist facilitated attitudinal change. Finally, the visitors were tested on their understanding of our specific research findings relating to facial expression (present on the signs). Those visitors who had read the signs exhibited greater knowledge and understanding than those who had not. These are the first quantitative data to demonstrate actual, tangible learning from a zoo-housed research focussed exhibit, and have since been published in a high impact peer reviewed journal [3].

The research has had a specific educational impact on children. We conducted a focus group with local college teachers, conducted quantitative surveys with parents/guardians at Marwell Zoo and conducted an online survey with teachers taking school groups to Marwell Zoo between January and August 2013. Over 80% of respondents reported that the MSC supported student learning at school and teachers rated 'watching the scientist' as the most educational activity at the MSC [8]. The potential for further public engagement at this specific site has also been recognised by the British Psychological Society, who awarded £19,340 to Bridget Waller (and Katie Slocombe at the University of York) as part of their public engagement grant scheme (see grant 3). Interactive touchscreen games have been developed and installed at the MSC and Edinburgh Zoo Budongo Trail chimpanzee enclosure based on the research conducted at the two sites [9]. Overall, 24% of visitors (and 44% of 11-21yr olds) use the touchscreens. Thus, since installation in March 2013, we estimate 96,000 visitors have used the games in Edinburgh Zoo, and 60,000 in Marwell Zoo. Visitors who engage with the games perceive science as significantly more interesting than a control group, and demonstrate increased knowledge about research findings explained in the games [10]. As young people play on the games significantly more often than adults, the games have the greatest impact within this age group.

Animal welfare has been enhanced by our research. The testing process has a beneficial effect on the macaques by decreasing aggression and increasing positive social behaviours [data published in a scientific article: 4]. As the macaques voluntarily separate from the social group when they use the touchscreens, this emulates wild patterns of behaviour where the group members have brief episodes of separation followed by reunion.

Practitioners have used our research findings. Within the zoo community the Macaque Study Centre has attracted considerable interest. Micheletta was invited to talk at the British and Irish Institute of Zoos and Aquaria (BIAZA) Mammal Taxon Working Group (October 2012) to introduce touchscreen training primates in a zoo environment. Dr. Antje Engelhardt (German Primate Centre, Germany) is building a similar facility at Darmstadt Zoo (Germany) modelled on the MSC (after visiting our facility and seeing the benefits for public engagement, animal welfare and scientific productivity [5]), and the Owl and Monkey Haven (Isle of Wight) are working with us to develop a similar facility with two new species of macaque.

5. Sources to corroborate the impact

1. Marwell Wildlife: Letter of support from Chief Executive Officer (Marwell Wildlife) detailing how our research collaboration fits with their scientific and educational mission.
2. Marwell Wildlife: Letter of support from Acting Head of Education (Marwell Wildlife) detailing current practice (and future plans) integrating our research into teaching workshops and educational materials at Marwell Zoo.
3. Published peer-reviewed scientific paper evidencing the educational impact of our research on visitors at Marwell Zoo: Waller, B.M., Peirce, K., Mitchell, H., Micheletta, J. (2012). Evidence of public engagement with science: Visitor learning at a zoo-housed primate research centre. *PLOS ONE* 7(9): e44680. doi: 10.1371/journal.pone.0044680 (1683 article views since publication, above average for psychology articles in PLOS ONE)
4. Published peer-reviewed scientific paper evidencing the animal welfare benefit of cognitive testing with zoo-housed primates: Whitehouse, J., Micheletta, J., Powell, L.E., Bordier, C., Waller, B.M. (2013). The impact of cognitive testing on the welfare of group housed primates. *PLOS ONE.* doi:10.1371/journal.pone.0078308
5. Letter of support from Head of 'Primate Sexual Selection' Research Group at the Leibniz Institute for Primate Research (Germany) detailing the development of a similar facility at Darmstadt Zoo (Germany) in light of the published public engagement, animal welfare and scientific impact of the MSC.
6. Marwell Wildlife: Zoo website with details about the collaborative project and links to the Macaque Study Centre website - http://www.marwell.org.uk/conservation/default.asp?css=1
7. Marwell Wildlife: Trustees' Report and financial statements (2011) detailing the number and profile of visitors to the zoo during the period 2010-2011- http://www.marwell.org.uk/downloads/MarwellWildlifeStatutoryAccounts31Dec2011FINAL.pdf
8. Report submitted to Marwell Wildlife detailing the results of our qualitative and quantitative survey of parents and educational professionals about the educational impact of the MSC.
9. British Psychological Society: Link to British Psychological Society website giving information about the educational games they funded us to develop and evaluate at Marwell Zoo: http://www.bps.org.uk/news/are-you-cleverest-primate
10. End of grant report submitted to the British Psychological Society: summarises the findings of our evaluation of the educational impact of the visitor games (that there is a specific and positive educational impact on children and young people).