Institution: University of St Andrews

Unit of Assessment: A4 – Psychology, Psychiatry and Neuroscience

Title of case study: 'Living Links to Human Evolution' Research Centre: research-led public engagement with science

1. Summary of the impact (indicative maximum 100 words)

World-leading primate research by the 'Origins of Mind' group led to the creation of the University's £1.6M 'Living Links to Human Evolution' Research Centre, intentionally located in Edinburgh Zoo where it has **pioneered unique public engagement and science education** using a range of materials and activities. The research has thus impacted on: **i) society and culture**: since 2008, around 250,000 visitors per year have engaged with live, on-going science and multiple associated legacy resources and activities; **ii) educational practitioners and school children**, through classes in the Centre and internet teacher packs that integrate with Scottish Highers; and **iii) commercial income** to the Zoo.

2. Underpinning research (indicative maximum 500 words)

The School is recognised for world-leading research on primate behaviour and cognition. The reputation of the 'Origins of Mind' research group has continuously risen since the appointments of Andrew Whiten (1975 to present) and Richard Byrne (1976 to present), and later others, notably Klaus Zuberbühler (2001 to present). All three professors have been elected Fellows of the Royal Society of Edinburgh (Whiten, 2001; Byrne, 2002; Zuberbühler, 2011), and Whiten is a Fellow of the British Academy (2000). During the REF period, their research has been supported by over £3.5M of grant funding, e.g., from ERC, John Templeton Foundation and National Geographic.

The research has focused on big scientific questions about the origins of major aspects of psychology, including culture, social learning, vocal and gestural communication. For example, in collaboration with 8 leaders of Africa's long-term study sites, Whiten published 'Cultures in chimpanzees', collating decades of field research to reveal 39 different behavioural traditions an unique local 'cultures' (Whiten *et al*., **Nature** 1999). Whiten also pioneered novel cultural diffusion experiments demonstrating a range of social learning processes in human and non-human primates (e.g. Whiten *et al*., **J Comp Psychol** 1996), as well as the capacity of chimpanzees to sustain multiple traditions in different groups (e.g. Whiten *et al*., **Nature** 2005). Byrne's research has examined the complex, hierarchical processing of food items by wild apes, leading to the highly influential concept of program-level imitation (Byrne and Russon, **Behav Brain Sci**, 1998). Zuberbühler's research has discovered features of language present in primate vocal communication, using sophisticated field vocal playback experiments to examine referential aspects of primate calls. This research has shown that primates communicate about different food values (Slocombe and Zuberbühler, **Curr Biol**, 2005) and that different meanings arise from different combinations of calls (Arnold and Zuberbühler, **Nature**, 2006).

Building directly on the international reputation thus earned, in 2004 Whiten and Zuberbühler led a successful £1.6M bid for a Strategic Research Development Grant (SRDG) from the Scottish Funding Council to establish a University research centre in Edinburgh Zoo, a collaboration with its parent organisation, the Royal Zoological Society of Scotland (RZSS). This funding was used to create an innovative research facility unique within the UK and comparable to leading primate behaviour research centres around the world (e.g., Max Planck Köhler Centre in Leipzig). The resulting 'Living Links to Human Evolution' Research Centre, opened in the Zoo in 2008, is owned by the University of St Andrews and contains mixed-species communities of ~70 monkeys. Large inner and outer enclosures are coupled with bespoke testing areas that monkeys enter voluntarily

and interact with experimental arrays, which has provided excellent facilities for testing the cognitive capacities of these monkeys. All research areas are in full view of the public galleries, fulfilling the key aim of Living Links to combine world-leading research with an unprecedented scale of public engagement. It does so through activities directly based on the research outlined above and this important impact link is explicated in section 4. Visiting children also take part in on-going child development studies paralleling those conducted on the non-human primates.

Whiten has been Director of Living Links since 2008. A recently appointed lecturer, Dr Amanda Seed (2010), is Deputy Director. St Andrews staff and students are the main users of Living Links, while research time is also bookable by other members of the Scottish Primate Research Group from Stirling, Edinburgh, Heriot-Watt and Abertay Universities. Additionally, since 2005, RZSS have been core sponsors of the Budongo Conservation Field Station in Uganda, of which Zuberbühler is the Scientific Director (2005 to present). Over 12 PhD and masters' level students from St Andrews have studied chimpanzees and other primates at the field site since. Based on the model of Living Links, RZSS also built the £5.6M Budongo Trail chimpanzee enclosure and visitors centre, opened later in 2008. This facility is used by St Andrews researchers to conduct studies on chimpanzees (e.g., vocalisation play-backs), and includes a 170-seat lecture theatre used in Living Links' public engagement programme.

3. References to the research (indicative maximum of six references)

These illustrative references are drawn from a total of >300 articles indexed for Byrne, Whiten and Zuberbühler since 1993. *Italics* = St Andrews researcher; **IF = impact factor**; **citations = *Scopus***.

Arnold, K. and *Zuberbühler, K.* (2006). Language evolution: Semantic combinations in primate calls. ***Nature**, 441*, 303. **IF ~ 36, 74 citations**, doi: 10.1038/441303a.

Byrne, R. W. and Russon, A. (1998). Learning by imitation: a hierarchical approach. ***Behavioral and Brain Sciences**, 21*: 667-721. **IF ~ 25, 279 citations**, doi: http://www.ncbi.nlm.nih.gov/pubmed/10097023

Slocombe, K. E. and *Zuberbühler, K.* (2005) Functionally referential communication in chimpanzee. ***Current Biology**, 15*, 1779-84. **IF = 10, 48 citations**, doi: 10.1016/j.cub.2005.08.068

Whiten, A., *Custance, D. M.*, *Gomez, J.*, Teixidor, P. and Bard, K. A. (1996). Imitative learning of artificial fruit processing in children *(Homo sapiens)* and chimpanzees *(Pan troglodytes)*. ***Journal of Comparative Psychology**, 110*, 3-14. **IF ~ 2, 172 citations**, doi: http://www.ncbi.nlm.nih.gov/pubmed/8851548

Whiten, A., Goodall, J., McGrew, W. C., Nishida, T., Reynolds, V., Sugiyama, Y., Tutin, C. E. G., Wrangham, R. W. and Boesch, C. (1999). Cultures in chimpanzees. ***Nature**, 399*, 682-685. **IF ~ 36**, **664 citations,** doi: 10.1038/21415 (identified by a *Lab Times* survey of animal behaviour papers as the **most cited of 19,000+ surveyed across all of Europe** from 1999 to 2010).

Whiten, A., *Horner, V.* and de Waal, F. B. M. (2005). Conformity to cultural norms of tool use in chimpanzees. ***Nature***, *437*, 737-740. **IF = 26, 191 citations**, doi: 10.1038/nature04047

4. Details of the impact (indicative maximum 750 words)

The research summarised in Section 2 has had substantial impact on: i) **society and culture**, through **public engagement with live science in action**, where beneficiaries have included ~250,000 public visitors each year since the opening of Living Links in 2008; ii) **practitioners in secondary school science education**, where the users and beneficiaries have been teachers and school children; and **iii) commercial income** through enhanced Zoo ticket sales.

i) Impact on society and culture Multiple strands of engagement based on the research have been built up since 2008: these include the **public being encouraged to view all research done in Living Links live**, over the shoulders of the scientists, through this and other activities thus learning about both our scientific discoveries including those outlined in Section 2, and the scientific methods used to obtain them**; involvement of parents and teachers in comparative child research**; a central **Science Exploration Zone** including numerous hands-on electronic and

physical activities; **public talks and discussions** in the Budongo Trail lecture theatre (e.g., 'Living Links to Human Health, Mind and Medicine', 2011; 'Twenty-first Century research associated with twenty-first Century zoos', 2012; supporting evidence **S6**); and **displays and murals**. For example, one interactive challenge that visitors are invited to engage with includes the 'panpipes' foraging tasks that require tool use for their solution and **replicate those used in the original chimpanzee research** (Whiten *et al*., Nature 2005, listed in Section 3). Each task is accompanied by video showing chimps using their local cultural technique; visitors are invited to solve the task themselves to gain an artificial grape (see photo). They are then directed to a second panpipes device where they see the alternative cultural approach, and through this are **led to understand more about both our scientific methods and our scientific discoveries themselves**.

Examples of other activities directly based on research outlined in Sections 2/3 include hands-on displays and video clips illustrating Zuberbühlers' research on primates' referential vocalisations. Together, over 20 such elements constitute **a substantial legacy resource of cultural artefacts supporting public and high-school engagement with science**.

Evidence of significance and breadth of impact:

a) ***Scale of visits*** Samples of direct counts of Living Links visitors together with calibrated broken-beam automatic entry counters, in conjunction with known Zoo entry gate numbers, allowed calculation that approximately 40% of visitors to the Zoo visit Living Links, thus amounting to approximately **~250,000 per year**, or over **1.5 million since 2008** (**S1**).

b) ***Sustained funding*** Funding agencies have expressed confidence in our impact by awarding a series of public engagement grants, supporting a full-time *Public Engagement Officer* (2009-2013). A Scottish Government engagement grant (**S7**) was followed by **two** from the **Wellcome Trust** (**S8**), the second **necessarily awarded only on the basis of the Trust's judgment that our public engagement work has had the impacts it was designed to have**. One of the public engagement exhibits ('My Primate Family Tree': see photo) was inaugurated by Prof. Anne Glover, Chief Scientific Adviser to the Scottish Government at the time and now Chief Scientific Adviser to the EU Presidency, indexing continued governmental support for Living Links.

c) ***Direct evaluation of engagement*** The Public Engagement Officer's quantitative data (**S2**) demonstrated that **visitors engaged with the materials in Living Links longer as more activities have been incorporated during the REF period**, and were **engaged the longest when active viewable research work was underway**. Unusually for these kinds of data, the quality of the exercise was such that results were published in a **well-respected, peer-reviewed journal** (Bowler MT, Buchanan-Smith HM and Whiten A. (2012). Assessing public engagement with science in a university primate research centre in a national zoo. PLoS One 7, e34505). For periods when the active research is not underway, video streams of research demonstrations are projected in the research rooms.

ii) Impact on practitioners in secondary school science education Under the sponsorship of a Wellcome Trust public engagement grant (**S8**) the Public Engagement Officer has created a series of **teacher packs** and made them available in 2012-2013 to **secondary school teachers of Scottish Highers in Biology** (Highers recently came to include primatology and animal behaviour) via the Living Links website, Living Links YouTube channel, and Times Higher Education Supplement websites. Three of the four teacher packs build directly upon the research described in Section 2; for example, the pack on 'Primate communication' **draws directly on the chimpanzee vocal playback experiments described above** (Slocombe and Zuberbühler 2005, listed in Section 3), guiding students to **understand the underlying principles of the science and learn about primate cognition**. The '*Measuring behaviour*' and '*Working with scientific literature*' packs

each include video clips made at Living Links for teachers to use in classes and a powerpoint presentation about the topic concerned. A teacher described the packs as '*highly engaging, relevant and current*', and stated that '*teachers and pupils will be greatly enthused*' (**S3**).

Evidence of significance and breadth of impact:

a) ***Teacher pack downloads*** Providing a **direct measure of change in practice of teachers**, data from the Living Links website, the Living Links YouTube channel and the Times Higher Education Supplement website record over **2,600 views** and over **1,500 downloads** of the packs to the end of July, 2013 (**S4**). Downloads have reached **beyond Scotland** to many countries (e.g. 18% USA). Thus, these materials are being **adopted by a substantial and diverse group of practitioners**. The Living Links YouTube Channel has 139 subscribers and 109,166 views (31/07/2013), and the total views of the primate education resources are 29,550 (combined Youtube and Vimeo to 31/7/13) (**S4**). Living Links also has a Twitter account for disseminating research and advertising events.

b) Teacher and class visits Complementing this outreach, **approximately 3,700 students per year take part in organised educational activities involving Living Links** (**S4**). In collaboration with the RZSS Education team, the Public Engagement Officer also conducts **summer science schools**, which have attracted ~50 children per year (2008-present) (**S4**). In 2012, a one-day **Global Classroom conference for secondary school students**, which included a chimpanzee communication workshop, attracted 220 students from 13 secondary schools, and a similar event in 2013 attracted 240 students (**S4**). Adult students have engaged with the research presented at Living Links via the **RZSS adult class** (72 students in 2012) and visits from the University of the Third Age (77 participants in 2013) (**S4**). Living Links is involved in the Zoo's Continued Professional Development events for science teachers, which attracted 23 science teachers from 15 schools across Scotland in 2013 (**S4**).

iii) Impact on commercial income benefits More people (661,763) visited the Zoo in the year that Living Links opened (2008) than in the previous year (607,763; 2007), equalling an **increased gate intake of approximately £750,000 at present prices** (**S5**). The CEO stated that the RZSS '*has benefitted enormously from the Public Engagement achievements of University of St Andrews researchers*', that '*Living Links is one of the most popular and educational of the exhibits in the Zoo*' and that the '*exceptionally high quality of the Public Engagement in Living Links has inspired our own Education Department to emulate and build upon these achievements*' (**S5**).

5. Sources to corroborate the impact (indicative maximum of 10 references)

S1 Estimates of visitor numbers to Living Links are based on samples of direct counts in conjunction with calibrated broken-beam entrant counters and known Zoo entrant numbers in 2011, plus annual Zoo entrant numbers 2008-13 held by RZSS Senior Education Department staff.

S2 Systematic, quantitative observational data on visitor dwell times are held by RZSS Senior Education Department staff. Confirmation letter available.

S3 Teacher packs are freely available at http://www.living-links.org/resources/materials-for-teachers/, and the quote is from a teacher at the Hutchesons' Grammar School, Glasgow (letter).

S4 Corroboration is through quantitative data provided by RZSS Senior Education Officer.

S5 Corroboration of Zoo visitor numbers and quote are provided by CEO, RZSS.

S6 Talks programmes are documented on page 22 of 'Living Links Public Engagement with Science' illustrated booklet on file and viewable at http://www.living-links.org/visitors-2/public/.

S7 Office of the Chief Scientific Adviser to the Scottish Government, 2009, Science Engagement Grant, *Living Links to Human Evolution, £18,000.* On record, University Grants Office.

S8 (i) Wellcome Trust Public Engagement People Award 2010 (WT09444MA), '*Living Links to Human Biology and Medicine'*, £29,995. ii) Wellcome Trust Public Engagement People Award 2012 (WT098133), '*Living Links to Human Biology and Medicine: Extensions & Outreach'* £29,196.