

Living Links

Public Engagement with Science



University of St Andrews
Scotland's first university

600 YEARS
1413 – 2013



The 'Living Links to Human Evolution' Research Centre

Opened in 2008, Living Links is a field station and research centre of the University of St Andrews, established in partnership with the Royal Zoological Society of Scotland and Edinburgh Zoo.



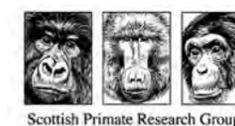
Virtually all research conducted at Living Links is performed in front of the viewing public

Living Links has large outside and inside enclosures in which capuchin monkeys and squirrel monkeys live together, and is designed to support studies by scientists at the Universities of St Andrews, Stirling, Edinburgh, Heriot-Watt, Aberdeen and Abertay, who together form the Scottish Primate Research Group (SPRG).

People-counters installed at Living Links suggest that around half the 650,000 or so annual visitors to Edinburgh Zoo visit Living Links and are encouraged to engage with the ongoing research there. Edinburgh Zoo is open virtually every day of the year (including Christmas day), and receives visitors from a wide spectrum of backgrounds.



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Live Science

Every researcher who conducts their work in the Living Links facility contributes to their university's public engagement work. Together, these efforts attain an extraordinary scale given their diversity, coupled with visitor numbers.

Living Links showcases a recognised strength of Scottish Science in a world class research facility

At Living Links, scientists from the Scottish Primate Research Group, which enjoys a global reputation, are joined by others from overseas institutions, including European and Japanese centres. Much research focuses on what we can learn of the origins of the human mind from studies of such topics as learning and communication in our close primate relatives.

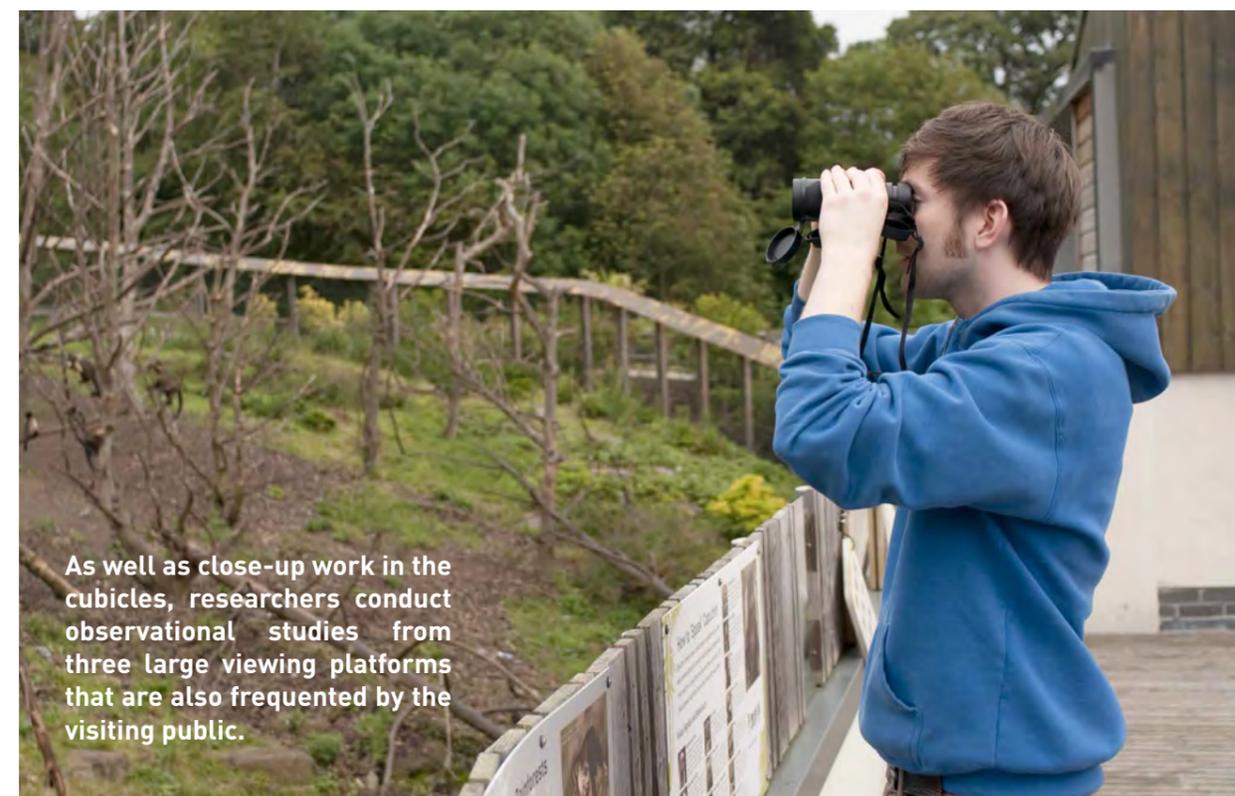


Living Links is designed to allow researchers to work closely with monkeys in the research rooms. Monkeys visit specially-designed 'cubicles' voluntarily to take part in experiments and receive rewards.

The Living Links primates are housed in generous outside enclosures with large inner rooms, all of which are designed as naturalistically as possible. This, and top-rate husbandry, ensure that the welfare of the animals is the priority that underpins successful public engagement.



Every experiment is accompanied by a projected panel that explains what is happening for interested visitors.



As well as close-up work in the cubicles, researchers conduct observational studies from three large viewing platforms that are also frequented by the visiting public.



Grant support for Public Engagement

The Public Engagement programme at Living Links has attracted external funding in the form of a series of grants from different sources. These are projects led by the collaborative team of Professor Andrew Whiten (St Andrews), Professor Hannah Buchanan-Smith (Stirling) and Stephen Woollard, Head of Education at RZSS.

2009 Scottish Government Science Engagement Grant
‘Living Links to Human Evolution’

2010 Wellcome Trust VIP Award
“Bridging to Wellcome Public Engagement with Science”

2011 Wellcome Trust Award
“Living Links to Human Biology and Medicine”

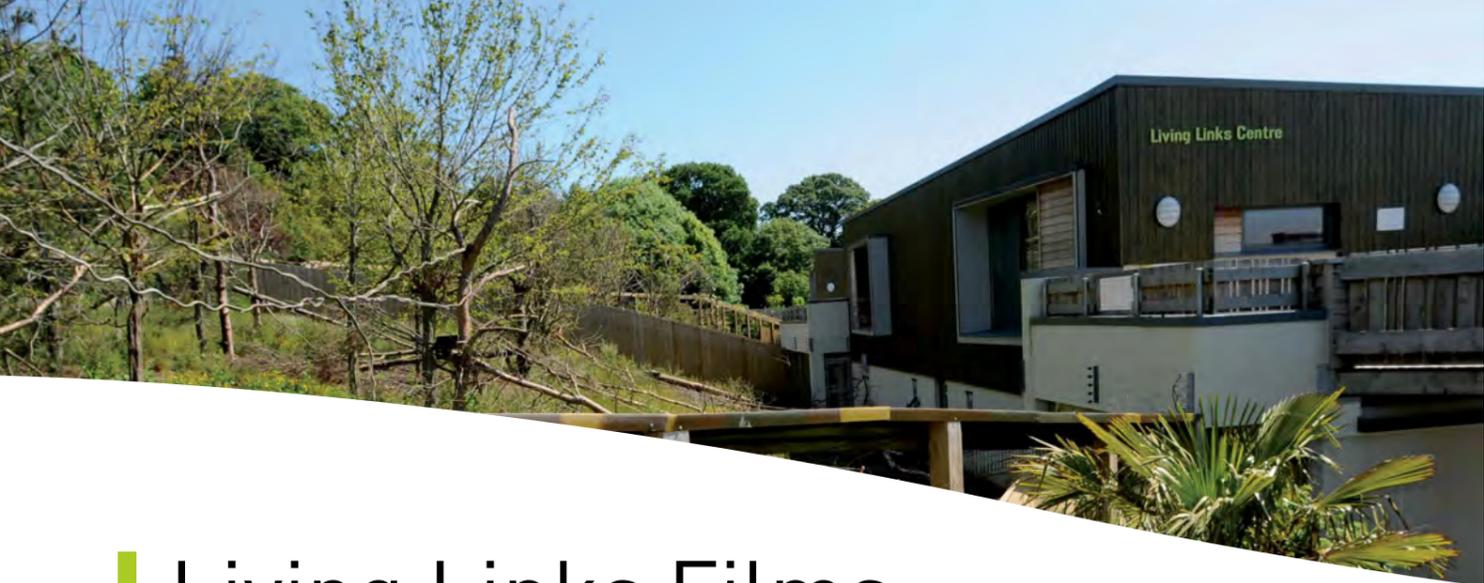
2012 Wellcome Trust Award
“Living Links to Human Biology and Medicine: Extensions and Outreach”



This series of grants has supported the employment of a full-time Science Communication Officer, Dr. Mark Bowler, an active research primatologist. His expertise in photography, video and design has been applied to the informed production of information panels, videos, computer interactive screens and numerous other public engagement materials and activities.



Our initial Scottish Government Grant enabled us to add a ‘Science Exploration Zone’ in the heart of Living Links, where a cluster of hands-on science activities are housed.



Living Links Films

A lasting legacy of more than twenty short films about Living Links, the primates and our research has been produced by our Science Communication Officer.



HD video for our hundreds of thousands of visitors

When no research is in progress at Living Links, our HD projectors show short film sequences about our work. Visitors can select from a menu using touch-sensitive buttons on the window.

Video Highlights



Seeing Colour

This film on the colour vision of primates and other animals uses accurate simulations of colour vision that we believe have never before been achieved in moving images.



Monkey Medicine

Living Links research on the self-medicative anointing behaviour of capuchin monkeys at Living Links has developed from our Public Engagement activities. This film has proven one of the most popular with our visitors.



Capuchins Calling

This film, on work by Professor Klaus Zuberbühler's research group, has been incorporated into resources offered by Learning and Teaching Scotland, to assist in teaching the Higher and Advanced Higher Syllabuses.



Calculated Gifts

Footage from this film on research by Living Links researcher Dr. Valerie Dufour on the ability of animals to calculate and trade has been adapted for national television.

A global on-line audience

Our audience is growing steadily through our internet channels on YouTube www.youtube.com/livinglinkscentre and Vimeo vimeo.com/channels/livinglinks where logged-in users can download videos for off-line educational purposes. Videos of our public lectures are also disseminated through these channels.





My Primate Family Tree

An iconic science-meets-art engagement project



Take your place in the tree....

We commissioned a large scale piece of artwork depicting the evolutionary tree of primates, populated by life-size apes and monkeys.



Visitors need little encouragement to stand in the correct evolutionary place for a human and 'join' the primate family tree by taking their photographs. In this way our visitors take home with them a lasting scientific message about their evolutionary origins.



Visitors can upload their images to our internet gallery of photographs, alongside scientific and other celebrities. Here, Professor Anne Glover FRSE, Chief Scientific Adviser to the European Community, inaugurates the mural. <http://www.living-links.org/visitors/tree-gallery>



We are proud to have joined forces with one of Scotland's finest young artists, Russell Dempster, to bring our tree to life.

Primate Genome Puzzle

We have produced matching sets of human and chimpanzee chromosome puzzle pieces. These form a game that graphically demonstrates the similarities and key differences between our genetic constitutions and those of our closest relatives.

Match Your Chromosomes with a Chimpanzee's!

Each giant puzzle piece illustrates a giant chromosome from either a chimpanzee or a human. They are similar but there are many differences too! Can you match the human chromosomes with the chimpanzee equivalents?

What is a chromosome?
Chromosomes are little rods made of long, coiled segments of DNA. This is where your genetic code, or genome, is stored. Each of your cells contains 23 pairs of each chromosome, unless you are male, in which case one of your pairs is made up of one 'X' and one 'Y' chromosome. You inherit half of your chromosomes from your father and half from your mother. Chromosomes were copied through many generations from your distant ancestors, down to you.

Chimpanzee chromosomes
Chimpanzees are our closest relatives and around 98% of our DNA is identical to theirs, so perhaps we should expect our chromosomes to look similar too? We shared an ancestor with chimpanzees around 65 million years ago, and chromosomes have been copied across many generations since. Changes or mutations have occurred during the evolution of each species.

Sorting chromosomes
The dark bands on your chromosomes appear when they are stained in a laboratory. Each chromosome has a different pattern that we can use to identify them. Scientists number chromosomes by length, largest first. Here we follow the numbering system for the human chromosomes.

Matching the chromosomes
If you first order the chromosomes by size, and then try to match the grey bands, we should be able to match up the chromosomes from the two species. Scientists used to match up chromosomes in this way to see how similar related different animals species are. Now we have more sophisticated ways of comparing their DNA!

Chromosome 1
Many of our chromosomes appear almost identical to chimpanzee chromosomes. The red band in each of the chromosomes in the chromosome and is used by the cell to put duplicated chromosomes away from each other when the cell divides.

Chromosome 2
Chimpanzees have 24 pairs of chromosomes rather than 23 in humans. Both human and chimpanzee chromosomes have a red band. Some regions of DNA sequence of the duplicated chromosome and some 'islands' can still be found.

Chromosome 3
Chimpanzees appear similar to chimpanzees and humans. This means that the ancestor that we share with the chimpanzees almost certainly had chromosomes that look like this one.

Chromosome 4
In chromosome 4, most of the bands match, but there is a section around the red chromosome that appears to have been removed and inserted upside down. This is exactly what has happened in the chromosome between the bands.

Chromosome 5
Four chromosomes carry genes that code for proteins. Both human and chimpanzee genomes contain about 20,000 protein-coding genes. Most of these are located on the same sections of the chromosomes between the bands.

Chromosome 6
When chromosomes are copied, some DNA is lost from each end, making them a little shorter at each end despite the fact that the important information, the one sequence of DNA sequence called 'telomeres' at the ends that do not contain genes.

Chromosome 7
Both human and chimpanzee versions of chromosome 7 contain a gene called 'PSD2'. It is thought that a mutation in the human version of this gene was important in the development of our speech.

Chromosome 8
Both humans and chimpanzees have about 2 copies of DNA in each of their cells. It is packed by being coiled into small protein structures called 'histones'. Chromosome 8 is about 100 million base pairs long.

Chromosome 9
The chimpanzee chromosome is likely to have an 'inversion' of an ancestor that had chromosomes like ours. When the section that is inverted includes the centromere, we call this a 'pericentromeric inversion'.

Chromosome 10
The DNA in chromosomes is made of long strands called up more than because they are more tightly bound together. The lighter bands are rich in the bases A and T (A-negative) and the darker bands are rich in the bases G and C (G-positive).

Chromosome 11
The chimpanzee chromosome is likely to have an 'inversion' of an ancestor that had chromosomes like ours. When the section that is inverted includes the centromere, we call this a 'pericentromeric inversion'.

Chromosome 12
The chimpanzee chromosome is likely to have an 'inversion' of an ancestor that had chromosomes like ours. When the section that is inverted includes the centromere, we call this a 'pericentromeric inversion'.

Chromosome 13
The blue bars show a group of genes that date to the body's 'proteome' and making features known as 'transcriptomes'. Humans and chimpanzees have 13 identical genes in this region. Humans and chimpanzees have a control role on the growth and function of all living things.

Chromosome 14
Another perfect match! When a chromosome is copied, some DNA is lost from each end, making them a little shorter at each end despite the fact that the important information, the one sequence of DNA sequence called 'telomeres' at the ends that do not contain genes.

Chromosome 15
The chimpanzee chromosome is likely to have an 'inversion' of an ancestor that had chromosomes like ours. When the section that is inverted includes the centromere, we call this a 'pericentromeric inversion'.

Chromosome 16
The chimpanzee chromosome is likely to have an 'inversion' of an ancestor that had chromosomes like ours. When the section that is inverted includes the centromere, we call this a 'pericentromeric inversion'.

Chromosome 17
Chimpanzee chromosome 17 has terminal bands of heterochromatin on each end and is found in all chimpanzee chromosomes, but are conspicuously absent in those of humans.

Chromosome 18
As well as the difference in the bands of the chromosome between chimpanzees and human versions of chromosome 18, there was also an insertion around the centromere that occurred in the human lineage.

Chromosome 19
Reversal of the insertion and fusion that have taken place since humans and chimpanzees diverged would result in virtually 100 percent matching of G-negative and G-positive bands.

Chromosome 20
Chimpanzees share versions of virtually all the 20,000 protein-coding genes found in humans! Changes in when and where genes are used to make proteins is what makes chimpanzees and humans different.

Chromosome 21
The chimpanzee chromosome 21 is one of the shorter chromosomes. The human version contains 48,287 base pairs and 326 genes, while the chimpanzee version contains 24,250,621 base pairs and 274 genes.

Chromosome 22
Like chromosomes 6, 13 and 19, the bands in human chromosome 22 is identical not only to that of chimpanzees, but also to that of gorillas and orangutans. Despite its small size, this chromosome contains 30,145,338 base pairs.

Chromosome X
Because male humans and chimpanzees only have one 'X' chromosome, they often have what are called 'X-linked' traits. An example of this in humans and chimpanzees is red-green colour blindness.

Chromosome Y
Apart from the addition of the heterochromatin marked in yellow, the 'Y' chromosomes of chimpanzees and humans are very similar. Both contain the 'SRY' gene that acts like a switch to tell the rest of the genome to make a male body.

Supported by **wellcome trust**

The puzzle is accompanied by a set of flexible learning activities designed in collaboration with teachers and engagement staff in the Wellcome Trust Centre for Cell Biology in Edinburgh, the Wellcome Trust Sanger Institute and the Open University.

School Syllabuses and beyond

The chromosomes have been used at the Cambridge Science Festival by the Wellcome Trust Sanger Institute and in lessons at Edinburgh Zoo. The activity addresses key themes from the Scottish Higher syllabus such as heredity, chromosome structure, duplication, deletion, translocation or inversion and even the formation of human chromosome-2 by fusion of ancestral ape chromosomes.

A downloadable version of the puzzle forms part of a flexible electronic teacher pack to support science teaching in the school environment. Available via www.living-links.org





Interactive Learning Stations

We have developed activities for visitors who prefer to explore Living Links themes through familiar computer-based platforms



Computers encourage many teenage and younger visitors to engage with scientific themes

Each activity is designed to be eye-catching and deliver a core message that is easily absorbed.



Complementing the 'My Primate Family Tree' mural, the 'Your Primate Family Tree' interactive features images from Mark Bowler's World Primate Image Archive, and is layered to reveal more and more detail as participants advance beyond a quiz, revealing the ancestors we share with our closest relatives.

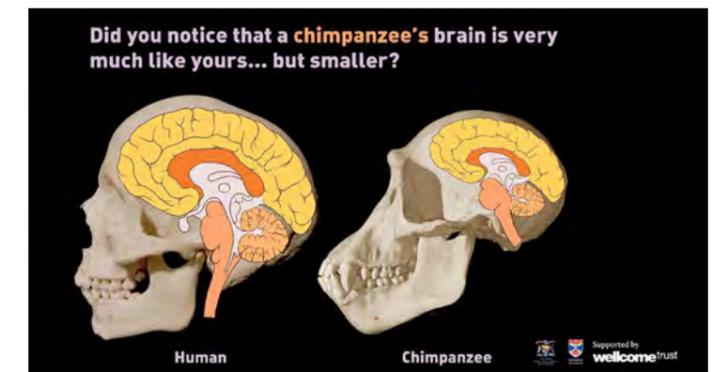


Our 'See like a...' primate colour vision interactive entices visitors to view unique video simulations of monochromatic, dichromatic and trichromatic primate vision.

It is narrated by Living Links researcher Professor Hannah Buchanan-Smith, who is actively involved in studies of the evolution of trichromatism in primates.



'The Brain Game' interactive highlights the basic similarities and differences between our own brains and those of other primates, making the connection with Living Links psychological investigations





Our signs use well-researched techniques and innovative presentation to layer scientific information in a way that is accessible to readers of different ages and educational backgrounds.

Testing of prototypes has refined the scope of information boards and their positioning so as to maximise their use. Our observational evaluations have shown that our information is read regularly and holds visitors' attention.

Science Engagement Panels

As well as providing regularly-updated information on our current and latest research, a rich array of attractive visual panels has been built up year by year.



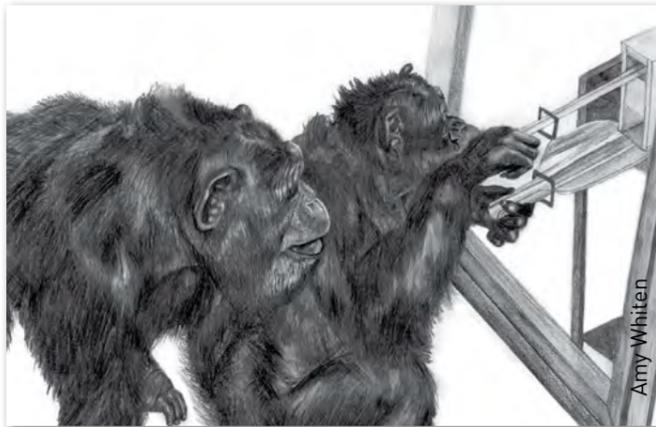
'Who's who' identification boards allow visitors to get to grips with the first job of researchers at Living Links; to identify the individual monkeys, whilst our visual guides to capuchin and squirrel monkey behaviour enable visitors to decipher primate communication patterns as they watch.

Our 'Spot the difference' genome frieze highlights similarities between our genomes and those of other primates. The eye-catching designs have since been used by the Wellcome Trust Sanger Institute at the Cambridge Science Festival.



Hands on 'Artificial Fruits'

Primate puzzles, identical to those used in our psychological studies, provide an even more hands on experience in the Science Exploration Zone.



We have produced versions of the primate puzzles known as 'artificial fruits' in our experiments, that visitors solve with the help of videos of primate demonstrators.

These 'games' give participants a real feel for the cognitive problems we are asking our primate subjects to solve in our research.

Children are often captivated by these activities, whilst their parents observe and read the accompanying explanatory material.



Visitor Participation

In addition to hands-on and other public engagement activities, we have created a variety of opportunities for visitors to participate directly in research at Living Links.



Primate behaviour studies have employed 'crowdsourcing' of visitors to monitor monkey activity, each volunteer completing a single behavioural 'scan'.

Many visitors have volunteered to take part in research on the cognitive abilities of both adults and young children.



Fun social learning studies such as a 'Spaghetti Towers' project overseen by Dr. Christine Caldwell of the University of Stirling challenged visitors to Living Links to build the highest towers made of spaghetti and plasticine, learning from those who tried before them.

Self-selecting activities have been a resounding success at Living Links

One such public engagement study involving visitor response cards inspired a research project that resulted in a publication in a high profile 'open access' scientific journal.

Claidière N, Bowler M, Whiten A (2012) Evidence for Weak or Linear Conformity but Not for Hyper-Conformity in an Everyday Social Learning Context. PLoS ONE 7(2): e30970. doi:10.1371/journal.pone.0030970



School and Youth Groups

Collaboration with the Royal Zoological Society of Scotland's Education Department has led to a series of successful educational visits from schools and other organisations.



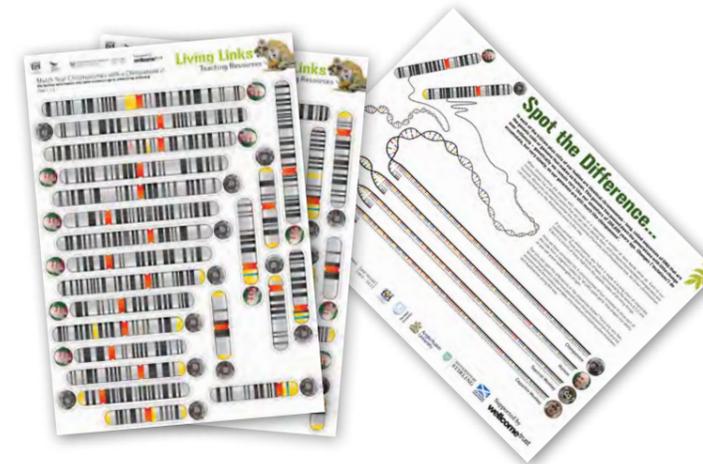
We believe that actively conducting behavioural science with live animals in a dedicated research facility, alongside real research biologists, creates a learning experience that will be exciting and memorable for visiting school-age children.

Our youth group activities aim to support efforts in increasing the uptake of science in schools.



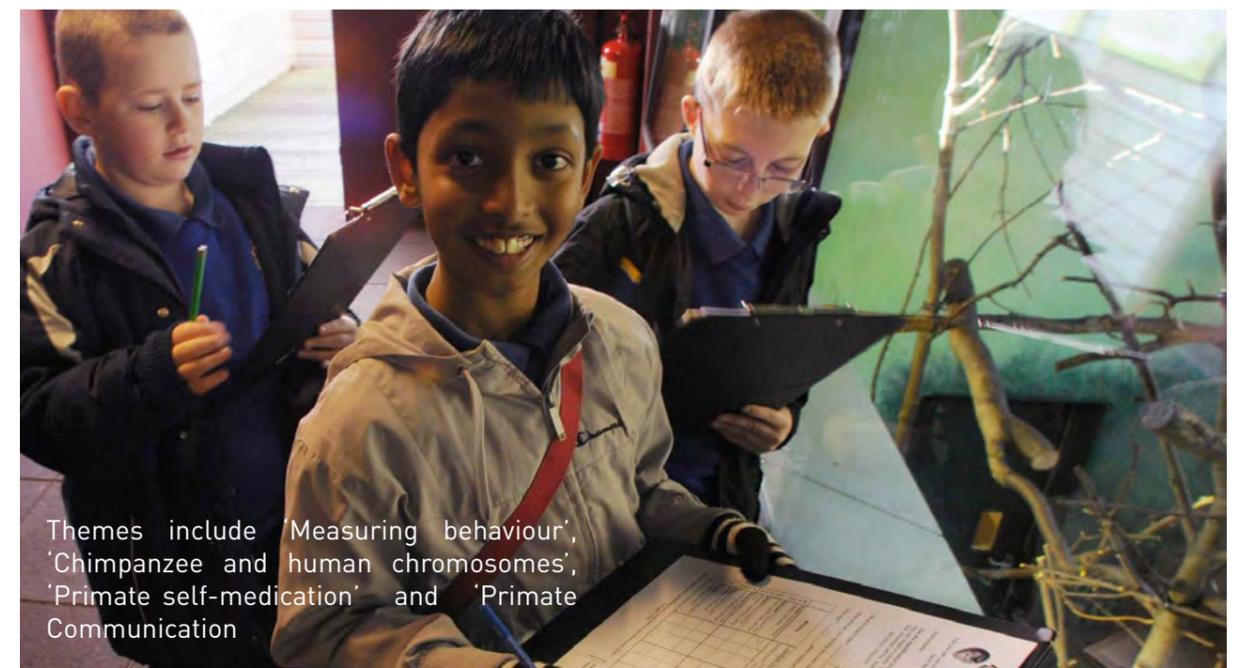
Teaching Resources

Our latest Wellcome Trust public engagement grant is enabling us to produce a series of on-line teacher packs and other resources to support science teachers in their own classrooms



All our teaching resources are freely available via www.living-links.org

Working closely with practicing secondary school teacher Dee McCarthy and building on her links with the Association for the Study of Animal Behaviour (ASAB), we have developed resources that have been used in teaching the Scottish Biology Higher. Several have been incorporated into the 'Learning and Teaching Scotland' web site for the Scottish Higher curriculum. These successes led to the development of customizable teacher packs, each with a lesson plan and video resources. Lessons can also be delivered with live animals in the Zoo as the subject matter.



Themes include 'Measuring behaviour', 'Chimpanzee and human chromosomes', 'Primate self-medication' and 'Primate Communication'

Lecture Series

Edinburgh Zoo's Budongo Lecture Theatre provides an excellent venue to host public lectures from a variety of leading scientists.



Public talks are held all year round on a variety of topics. Highlights have included our "Living Links to Human Health, Mind and Medicine" lecture series, for which we were able to attract the world's leading expert on primate self-medication in the wild, Professor Michael Huffman of the University of Kyoto, along with other talks on primate health and nutrition, Darwinian evolutionary medicine, and the evolution of HIV and AIDS in the primates of Africa.



Primate Medicines

Live public demonstrations of 'fur rubbing' or 'anointing' in capuchin monkeys led to an interesting line of new research at Living Links.



Wild capuchin monkeys rub strong-smelling substances onto their bodies, a behaviour that is thought to protect them against parasites. Onions and limes were originally provided on a regular basis as a public engagement activity in Living Links, but visitor interest soon stimulated research and data collection to tackle unanswered questions about the activity.



The Science Communication Officer supervises student projects under the "Nuffield Foundation Science Bursaries" scheme in collaboration with RZSS: for example, studying self-medication through 'leaf-swallowing' in Edinburgh Zoo's chimpanzees.



Dr. Nicolas Claidière

Evaluating Public Engagement

Public engagement activities are not often rigorously evaluated, but we believe this is an essential part of the development and improvement of these endeavours.



Our assessments have focused on measuring visitor interest in our exhibits and activities, by recording attraction, attention and overall dwell times. Visitors choose to spend longer watching scientific activities than anything else, and scientific conversations are regularly generated amongst groups at Living Links, during their day out at the Zoo.

The Science of Public Engagement

We consider it important to disseminate the results of our evaluations to as wide an audience as possible. We have therefore published in a prominent open-access journal. This paper generated interest amongst science communicators, who recognised both the novelty and the importance of publishing the results and the methods we used to obtain them (Bowler, Buchanan-Smith & Whiten 2012).



Workforce

Living Links Core Public Engagement Team

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Dr Valerie Dufour, Research Fellow; Dr Charlotte MacDonald, Research Coordinator - the starting Living Links team - for their foundational work

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Head of School of Psychology, University of St. Andrews; Professor Malcolm MacLeod; Professor Verity Brown

Jon-Paul Orsi (RZSS Digital Specialist) for photography, videos and coordinating the installation of 'Squirrel Monkey Cam'

Living Links Researchers: Dr Amanda Seed, Emily Messer, Eoin O'Sullivan, Dr. Koda Hiroki, Carolina Mayer, Alejandra Lapadula, Jack Griffey, Victoria Hartley, Blake Morton, Dr. Christine Caldwell - et al.!

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Polly Philpot, Ruth Fraser, Susie Crocker, Jenny Combes and all RZSS Education staff, especially those who have given talks at Living Links

Professor Aubrey Manning - Chair of Living Links Management Board

Recoat Design (www.recoatdesign.com) for foliage graphics in Science Exploration Zone and research rooms: Agent for Russell Dempster, My Primate Family Tree

Russell Dempster, Artist, My Primate Family Tree

RZSS Education Volunteers for help with many of our engagement projects

RZSS Senior Staff: Iain Valentine, Darren McGarry

Steve Smart, University of St Andrews, for additional design support

Visiting Speakers: Including Professors Michal Huffman, Gillian Bentley, David Perrett; Drs Josep Call & Katie Slocombe

Warpro (Alastair Young) for data projector support

Publications

Claidière N, Whiten A (2012) Integrating the study of conformity and culture in humans and nonhuman animals. *Psychological Bulletin* 138: 126-145.

Dufour, V. C. Sueur, A. Whiten & H.M. Buchanan-Smith (2011). The impact of moving to a novel environment on social networks, activity and wellbeing in two new world primates. *American Journal of Primatology*, Special Issue: on Social Networks in Primates 73, 802-811.

Leonardi, R., Buchanan-Smith, H., Dufour, V., MacDonald, C. & Whiten, A. (2010) Living Together: Behaviour and welfare in single and mixed species groups of capuchin (*Cebus apella*) and squirrel monkeys (*Saimiri sciureus*). *American Journal of Primatology*, 72, 33-47.

Macdonald, C. & Whiten, A. (2011). The 'Living Links to Human Evolution' Research Centre in Edinburgh Zoo: a new endeavour in collaboration. 2011. *International Zoo Yearbook*, 45, 7-17.

SPRG scientists are productive publishers of their scientific discoveries. Among these scores of publications, recent Living Links publication include:

Bowler, M., Buchanan-Smith, H., & Whiten, A. (2012). Assessing Public Engagement with Science in a University Primate Research Centre in a National Zoo *PLoS ONE*, 7 (4) DOI: 10.1371/journal.pone.0034505

Buchanan-Smith, H.M. (2012) Mixed-species exhibition of Neotropical primates: analysis of species combination success. *International Zoo Yearbook*, 46,150-163.

Claidière N, Bowler M, Whiten A (2012) Evidence for Weak or Linear Conformity but Not for Hyper-Conformity in an Everyday Social Learning Context. *PLoS ONE* 7(2): e30970. doi:10.1371/journal.pone.0030970



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