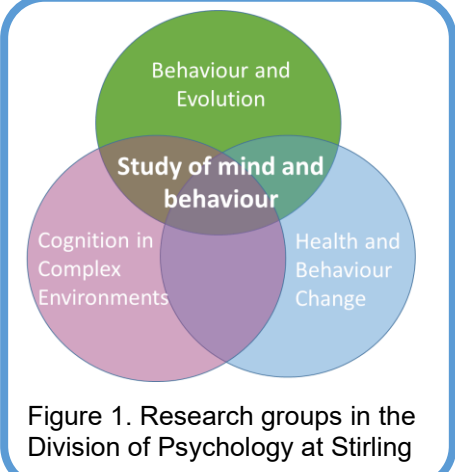


Institution: University of Stirling
Unit of assessment: A4 – Psychology, Psychiatry and Neuroscience
Section 1. Unit context and structure, research and impact strategy Unit context: Stirling's Division of Psychology conducts world-class research addressing fundamental questions about the mind and behaviour. Our unique strengths include innovative research on face processing, cognitive development, mobile cognition and cultural evolution. The Division comprises two research groups submitted to A4 UoA (<i>Behaviour and Evolution; Cognition in Complex Environments</i>) and a third group (<i>Health and Behaviour Change</i>) that works closely with Stirling Faculty of Health and Sport and is submitted to A3. In REF2014 our A4 submission was ranked 1st for Impact (out of 82 institutions) and 18th overall, achieving the highest overall GPA for a small volume submission (14 FTE). Since 2014 we have built on this success in the following ways: • We have attracted £4.8 million in funding, a ~50% increase in grant capture since 2015. • We have made a significant investment in staffing, with the appointment of 11 early career staff. • We have increased our research capacity by investing in cutting edge equipment (e.g., Infrared Spectroscopy (fNIRS) and mobile electroencephalography (EEG)) that allows new insights into psychological questions, in laboratory and real world contexts. • We have produced research that has improved animal welfare, motivated changes in the UK guidelines for football heading in children, improved the facial composite detection of criminals and improved the experiences of prison inmates. These developments are underpinned by specialist research facilities. These include a unique, in-house Kindergarten for the study of neurocognitive development, as well as laboratories for facial, spatial and perceptual cognition. Structure of the unit: This A4 submission includes two research groups (27.4 FTEs), but in practice members of all three Divisional research groups work closely together (Figure 1). Here we provide brief overview of the groups in this submission. OUR VISION: to increase understanding of mind and behaviour and use these findings to improve the health and wellbeing of humans and other animals. The Behaviour and Evolution Research Group (BERG) focuses on cognition, communication and welfare in a wide range of species (and primates in particular, including humans). This group uses evolutionary principles to guide interdisciplinary research investigating the phylogenetic origins, mechanistic operation, ontogenetic development, and fitness benefits of human and nonhuman behaviours (Buchanan-Smith, Caldwell, Fedurek, Kessler, Lee, Martin-Ordas, Roberts, Vick). The Cognition in Complex Environments Group focuses on neuropsychological and cognitive development throughout the lifespan, from birth to senescence. This group uses neurophysiological measures (EEG, mobile EEG, fNIRS and single-unit electrophysiology) to assess how the brain processes spatial information and memories (Argyropoulos, Bobak, Cage, Dering, Dudchenko, Fukumura, Gheorghiu, Goutcher, Grainger, Hancock, Ietswaart, Keitel, Kourtis, Kuipers, Langton, MacLeod, Park,  Figure 1. Research groups in the Division of Psychology at Stirling

Rafetseder, Reader and Wilson).

How we have achieved our strategic aims for research: In this REF period our aims were to i) increase our developmental and social psychology expertise, ii) enhance our research capacity and extend it to non-laboratory contexts, and iii) strengthen interdisciplinary research links. We have achieved these aims in the following ways:

i) We have focussed on hiring and developing early career researchers to achieve our strategic aim of making **developmental psychology** a new area of strength. This has led to success in attracting external funding, including the new *Schooling Across Neurocognitive Development* project, funded by the Jacob Foundation, which explores how brain development underpins school readiness. A second example is a Leverhulme Early Career Fellowship that was

BOX 1. Our structure facilitates cross-cutting collaborations.

For example, developmental psychology has emerged as a key strength, with involvement from different research groups: Grainger and Cage (*Cognition*) use cognitive tests to investigate developmental disorders in the new Stirling Autism Research Laboratory; Martin-Ordas (*Behaviour and Evolution*) uses comparative methods to study episodic future thinking; Rafetseder and Wijeakumar (*Cognition*) use neuroimaging to examine working memory in children; Caldwell (*Behaviour and Evolution*) uses both developmental and comparative approaches to test cognition and cultural evolution in both non-human primates and human children. Together, these form a vibrant area of strength in the study of cognitive development.

awarded to study the development of face processing in children and young adults. Also, an Academy of Medical Sciences-funded project focuses on prospective memory in children with autism spectrum disorder, and a recently awarded a Royal Society of Edinburgh Sabbatical Research Grant will support the study of anxiety in autism. We have also strengthened our **social psychology** research profile by appointing researchers that fit within our existing groups, but who investigate inherently social issues. These include new research on language production and comprehension (Fukumura), the evolution of human approaches to caring (Kessler), the evolution of cognitive processes (Martin-Ordas) and communication (Fedurek), memory and emotion regulation (Argyropoulos) and the neural correlates of joint action (Kourtis and Reader).

ii) We have increased our research capability using the funding generated by success in the previous REF to acquire specialised, cutting-edge equipment that enables staff to exploit new and emerging research fields. We have added skills and equipment in functional near-infrared spectroscopy, mobile EEG and mobile eye-tracking, virtual- and augmented reality, brain stimulation, mobile electromyography (EMG) with foot-pressure insoles for monitoring walking/gait, and human-robot interactions (see Box 2).

For the instrumented person project, now known as 'Mobile Cognition', our aim was to move **beyond the laboratory** and allow EEG and psycho-physiological equipment to be routinely used in naturalistic, everyday settings. To support this we invested in mobile eye-tracking equipment, significantly extending the range of contexts in which eye-tracking can be used (leading, for example, to current projects involving the visual attention of children in classroom environments). Alongside hardware, we have invested in the development of software through our dedicated technical support team (which includes two full time electronic engineering and programming technicians), allowing researchers to combine mobile EEG, eye-tracking and EMG or foot-sensors, as well as allowing time-based and event-locked analysis of heart rate variability data and action-related events. Success in this new approach is evidenced by the first demonstration that mobile EEG can be employed to measure the division of attention during walking in naturalistic contexts (Ladouce in *Scientific Reports*, 2019: tinyurl.com/zmpctzre). The focus on building capability has allowed us to pioneer the use of mobile neuroimaging methods, moving research from constrained laboratory-based situations into real-world scenarios. These include the neural signatures of students selecting books in the library or of Parkinson's patients avoiding obstacles. This approach has provided a paradigm shift for cognitive research by taking it beyond the laboratory (Ladouce in

Frontiers in Human Neuroscience, 2017: [tinyurl.com/28dyf9e5](https://doi.org/10.3389/fnhum.2017.00095)).

iii) To drive scientific opportunities, we have emphasised **interdisciplinary research** and methodological innovation. This has been facilitated by the University of Stirling's research strategy, which has three overarching themes: *Cultures, Community and Society, Global Security and Resilience and Living Well*. As well as aligning research with these themes, 12 interdisciplinary research programmes have been prioritised by the University – 10 of which involve researchers in Psychology, and two of which are led by Psychology (*Health and Behaviour* and *Mobile Cognition*). These programmes have brought internal investment into Psychology (including four funded Ph.D. studentships, a postdoctoral fellow and new equipment), and encouraged interdisciplinary projects. For example, a member of the *Behaviour and Evolution* group interested in episodic memory and future thinking in children and animals has developed links with colleagues in Biological and Environmental Sciences at Stirling to study cognition in bees (leading to a collaborative grant from the Leverhulme Trust, £369K). A member of the *Cognition* group is working closely with a UKRI Fellowship holder from Philosophy scheme to test belief revision in pigs, dogs and human children. From within the University's **Mobile Cognition** programme, members of the Psychology Division have collaborated with colleagues in the Division of Sports Studies on a large-scale, cross-cultural study on aging in Scotland and South Africa (currently underway). In addition, Medical Research Scotland is supporting a research project combining neuroimaging and sports medicine.

In addition to the collaborations and grants mentioned above, the vitality and sustainability of our research groups is evidenced through other awards. The *Behaviour and Evolution* group has attracted a major European Research Council Consolidator grant (£1.3 million) to investigate cognitive mechanisms that generate human cumulative culture (Caldwell). This funding supported four Ph.D. students and two post-doctoral fellows, and has provided new evidence on how children acquire the capacity for imitation. Also in this assessment period, *Behaviour and Evolution* group has attracted funding from the BBSRC and the National Centre for Replacement, Refinement & Reduction of Animals to work with industry partners (GlaxoSmithKline; Charles Rivers Laboratories) to improve the welfare of animals used in scientific experiments. The impact of this work is described in the *Improving Health and Wellbeing of Laboratory-Housed Animals* case study that is part of this submission.

In the *Cognition* group, funding has been awarded for research in several of our areas of research strength. For example, three awards from the BBSRC have supported research on human EEG and memory for faces, as well as the neural correlates of spatial navigation (total: £717K). A member of this group is the Psychology lead on a 5-year EPSRC programme grant to develop automated face recognition (£665K to Stirling). In visual perception, new research has been developed in stereoscopic depth perception and scene segmentation supported by the Defence and Security Accelerator fund and a grant from the UK Government Office for Science. Work on symmetry perception, colour and shape perception has been supported by grants from the Wellcome (£208K) and Leverhulme Trusts (£123K). As a final example, an early-career researcher in the *Cognition* group produced a top-rated proposal from the ESRC (£383K) for work on the

BOX 2. New research on human-robot interactions



How humans interact with one another has been a central concern for psychology since its inception. In today's world, however, our interactions are increasingly virtual or with machines. How we coordinate our efforts – both at the level of joint action and in decoding the intentions of others – is a new research focus within the Division by Kourtis (appointed in 2017), in collaboration with colleagues at Heriot-Watt University.

detection of concealed recognition of faces. This success was underpinned by Divisional funding for this member of staff to develop links with collaborators in Japan.

How we have achieved our strategic aims for impact: The Psychology Division is part of the Faculty of Natural Sciences and we have embedded impact within our research culture via the *Faculty of Natural Science's Impact Strategy*. This has three objectives: improving impact literacy through training and the sharing of best practice, enabling identification of a wide range of potential and ambitious impact objectives, and recognising and tracking impact as it happens. To achieve these, within the Division we have an Impact Champion who works with the Faculty's Associate Dean of Impact and the Faculty Impact Committee to further impact activities. In addition, our impact case study authors act as 'impact ambassadors', sharing knowledge, skills and insights gained during their journeys to successful outreach. We also share our best practice and learn from others across the institution through engagement with Impact Champions in other faculties. To assess how these objectives are achieved, impact contributions are a standing item in our annual *Achieving Success* performance review and are recognized in the promotion process.

Under our impact strategy we have funded and facilitated engagement with non-academic stakeholders. Examples of this include:

- Work on human-animal interactions (*Behaviour and Evolution group*) has shown that the introduction of a dog-training programme for rescue dogs in a young offenders institute improved self-efficacy, emotional management and reduced impulsivity for the inmates, as well as improved dog welfare. This has led to the uptake of this programme in two additional prisons and the development of a similar programme in the Serbian Prison Service.
- We have hosted local authority education policy officers, teachers and researchers from education to a workshop on enhancing teaching based on our findings in the use of metacognition in education
- We have hosted experts from industry and government in a workshop on improving animal housing, husbandry and scientific procedures in commercial laboratories. This led to two successful grant applications (BBSRC and NC3Rs), in collaboration with industry, to develop best practice exchange. Our researchers also contributed to changing the Secretary of State's Guidelines for the Management of Zoo Animals (elephants) through participation in industry welfare committees.
- We have hosted sports coaches and experts from concussion related charities to an event to discuss our recent research on football heading. This event led to the development of links with a company developing protective headgear, who subsequently funded two Ph.D. studentships. It also led to an additional studentship funded by Medical Research Scotland.
- We brought together academics and those interested in the design of facilities for those suffering from memory loss for a *Neuroscience and Dementia Design* workshop that highlighted research on brain representations of the outside world. This workshop and the underlying research were funded by a BBSRC award in the *Cognition* group.

In addition, the University has invested in Post-Doctoral Impact Fellowships, aligned to the Research Programmes. For example, the Impact Fellow appointed to **Mobile Cognition** provides an interdisciplinary link between Psychology and Philosophy.

Principles guiding future strategy: At a time of change due to the Covid-19 pandemic, we are responsive to emerging research questions and working to mitigate risks. In the immediate term, we are seeking to:

- *Explore new questions.* The current public health crisis has raised questions which we are well-placed to address. For example, our Developmental Psychology group is using a citizen-science approach to assess how to safely return children to nurseries (in the Psychology Kindergarten) and the Face Lab has investigated recognition of masked faces.
- *Refine the way we conduct our face-to-face research.* In the immediate future, we are working within established guidelines (e.g., the Simmons and Luck (2020) protocol) to ensure that safe practice is maintained in face-to-face testing, for example, with the application of EEG electrodes and fNIRS optrodes.
- *Develop creative new ways of working.* For example, we have recently invested in wearable electroencephalogram (EEG) technology that can be used by participants to record data in their own homes. This is being used to assess EEG correlates of attention and wakefulness (e.g. alpha rhythms). Such efforts ensure the sustainability of our research, independent of the circumstances.

Over the next five years our research groups have three aims:

- To understand developmental disorders in order to improve developmental experience:
 - Use the new *Stirling Autism Research Laboratory* to conduct high-quality autism research, which aims to better understand and support autistic children, young people and adults, with a particular focus on improving wellbeing.
 - In the early years: understand development as it relates to readiness for schooling. This will have far-reaching impact for education policy-makers, education providers and parents.
 - In adolescence: Improve how students handle transitions, particularly the move into university and the move beyond university. One focus will be on how students understand their own thinking (metacognition), as well as bio-psycho-social factors changes and brain development. This will lead to interventions in secondary and higher education establishments to improve outcomes.
 - In developmental disorders: understand the mental health challenges in adults and children.
 - These will be taken forward by the *Cognition* research group, and we will focus on supporting the cluster of researchers in developmental psychology within the Division. As described in the infrastructure section below, we are well placed to capitalise on this strength with our in-house Kindergarten.
- To understand evolution and mechanisms underpinning behaviour as well as improving the welfare of humans and animals:
 - Use a One Health/One Welfare approach that recognises the health and wellbeing of humans, animals and the environment are inextricably interlinked to develop *Stirling's Human Animal Interaction Research* group as a hub for international collaboration. This will guide policy and practice in animal husbandry, with implications for human-animal impact in settings such as hospitals and schools. Given that the global pandemic originated at the human-wildlife interface, linking biodiversity exploitation with animal and human health is essential.
 - Use an evolutionary and comparative approach to understand how care-giving behaviours for sick individuals evolve in nonhuman animals and humans. This will help us to understand how human healthcare systems have evolved and how we, as a species, have responded to infectious diseases over evolutionary time (including during COVID-19).
 - Lead on the expansion of Living Links (the collaborative research field station at

Edinburgh Zoo) both locally and internationally by incorporating Blair Drummond Safari Park and a Living 'wild' Link field station in Suriname as allied outposts. This will link research in captivity and in the wild, generating ecologically valid hypotheses that can be tested in a variety of settings.

- Collaborate with international research field sites in Uganda (Kibale Chimpanzee Project, Budongo Conservation Field Station) and Ivory Coast (Tai Chimpanzee Project) studying wild chimpanzees and promoting wildlife conservation.
- These will be taken forward by the *Behaviour and Evolution* research group, with a particular focus on delivering impact by promoting the welfare and conservation of animals, and positive interactions between humans and animals.
- To understand core psychological processes during movement:
 - Investigate functional and neural mechanisms of perception, memory, language and action using novel techniques. One goal is to exploit our mobile cognition technology to measure multiple physiological and psychological measures simultaneously (e.g., integrated mobile eye-tracking, movement recording and EEG).
 - Using mobile cognition expertise to assess brain-behaviour relationships in a variety of contexts including sporting behaviour (football heading and concussion), aging populations (monitoring gait and eye-movement in the elderly), clinical populations (gait and mobile EEG in Parkinson's patients) and the interactions between humans and robots.
 - These will be taken forward by the *Cognition* group, and specifically by the ***Mobile Cognition*** research programme (in collaboration with researchers in Sports Studies).

Section 2. People

Staffing strategy: The key strategic aim for the Psychology Division has been to attract and develop a talented group of academics to enhance our vibrant research environment. Our focus is on the recruitment and development of early-career researchers to add new areas of expertise (e.g., autism and developmental disorders) and to expand our range of research techniques. To that end we have invested in 11 new lecturers since 2018. Additionally, Bobak, who secured a Leverhulme Early Career Fellowship, will transition into a full-time lectureship in January 2023. This development is also reflected in our promotion success, with two new Professors, two Associate Professors and three Senior Lecturers during the assessment period.

Highlights of The Division of Psychology's staffing strategy include:

- *A commitment to equality and diversity.* The University's commitment to gender equality was recognised in the institutional Athena SWAN Bronze award in 2016. Psychology is committed to achieving Departmental Athena Swan recognition (currently submitted), and Equality, Diversity and Inclusion (EDI) is a standing item at Faculty and Divisional meetings. We have improved awareness and avoidance of the conscious and unconscious biases that affect all stages of recruitment and advancement in research with training for staff on these panels. The Psychology Division now provides a six month research leave after maternity leave and this has been successful: following maternity leave, a member of the *Cognition* group used her paid research leave to prepare a research bid on metacognition in autism which was awarded in 2020 from the Royal Society of Edinburgh. Staff on leave are invited to our staff away days with full support for attendance with an infant. As described above, the Division features a Psychology Kindergarten and Toddler group, which can be used by all staff and students, and this supports our EDI strategy. Psychology committees, meetings and seminars are scheduled between 10-4, to allow those with child-care responsibilities to attend. In a staff survey conducted in 2020, 87% of staff in the Psychology Division agreed/strongly agreed that '*Psychology had provided them with adequate support during lockdown*', regardless of gender.

- *Balancing workloads* Our promotion of equality and diversity applies to the balance of impact of administrative and teaching tasks on researcher productivity. Staff are formally assigned a ratio of 40:40:20 workload for research, teaching and administrative duties respectively, which we monitor in staff appraisals. As noted above the allocation of key roles in the Division is gender-balanced. All new members of staff are paired with a senior mentor to help guide their efforts towards research success and promotion.
- *Fostering an interdisciplinary view of psychology* Eleven of our research staff did not study for an undergraduate degree in psychology or associated disciplines. Researchers' first degrees in pure and applied biology, chemistry, physics, anthropology, literary arts and engineering demonstrate our commitment to supporting non-traditional, multi-disciplinary routes into psychology, recognising the benefits they bring.
- *Valuing different backgrounds* We have recruited research staff from Australia, Austria, Belgium, France, Holland, Germany, Greece, Japan, Poland, Romania, Sri Lanka and the United States included in this submission. This staff composition ensures that the Division is truly international, outward-looking and engaged with internationally recognised research from across the globe (see Figure 6 below).

Staff development: The Division of Psychology strives to provide a supportive and intellectually stimulating environment for all staff. The University subscribes to the Concordat to Support the Career Development of Researchers, and within the Division early career researchers are nurtured within each research group and within an early career support group. In addition, training and development planning are a central part of Stirling's *Achieving Success* annual progress review. In this review, annual plans are discussed with a senior colleague and staff are asked to identify development needs in the context of their current role and their professional ambitions. The *Achieving Success* process is also dynamic: in the summer of 2020, for example, all plans were revisited in light of the challenges arising from the Covid-19 pandemic.

Staff development is also supported in the following ways:

Support from colleagues. Personal development is supported through regular Division and Research Group meetings.

Divisional weekly seminars provide an opportunity for staff and students to engage with internationally-recognised speakers. In addition, each semester the Division runs a themed away-day, involving research, administrative and support staff. The agenda for the away days includes organisational knowledge-sharing and technical training, as well as exercises to support and develop group coherence. Research groups meet weekly to provide on-the-ground support for identifying funding opportunities, providing peer support for research bids, fostering impact and supporting postgraduate researchers (see Figure 2). For example, the *Cognition* group has a weekly 'cognition-and-cake' session where one researcher presents their new findings to the group. *Behaviour and Evolution* have weekly drinks and nibbles talks where dogs and children are also welcome. There is also a social 'cake-Tuesday' for the entire Division to foster collegiality and friendships, especially important for welcoming new staff

Opportunities for training. A wide range of training and development opportunities are provided by Stirling University and the Faculty. Division-level training focuses on skills and methods relevant to



Figure 2. Weekly meeting of the *Cognition and Complex Environments* research group. Each research group acts as a sounding board for new research findings and research directions.

our researchers, including general research tools (such as using Research-Professional or Altmetric) and specialist techniques (such as use of Qualtrics, Testable, multi-level modelling and eye-tracking).

Flexibility to try new things. We encourage staff to be ambitious and to be confident that risks or changes in research focus will be supported. For example, as a new member of staff Dering came to Stirling from a Ph.D. focused on Event Related Potentials and face detection. In establishing his own direction, he developed a research interest in the effects of alcohol on cognition. He was supported to retain *in vivo* studies (collaborating with researchers in Italy funded by SINAPSE) and via a Ph.D. studentship funded by the Division on the effects of binge drinking. Whilst this reframing had risk, it has been successful: Dering now has a new programme of research, with strong potential for long term impact, and has recently developed a new collaborative Ph.D. studentship with a company (*One Year No Beer*) promoting alcohol reduction.

Time for research. As well as supporting skills development, we protect researchers from encroachment into the time allocated for research and provide opportunities to ring-fence quality research time. The Faculty workload model provides a reduction in the teaching by 50% in the first year for new staff to allow their research to thrive from the outset. All staff also benefit from the opportunity apply for Research Leave (6-months leave after 6 semesters of service or 12-months leave after 12 semesters) to focus entirely on developing international collaborations and impact, to submit multi-centre grant applications and to publish high-quality research papers. Since REF2014 a total of 22 periods of Research Leave have been awarded and these have yielded successful funding bids (e.g., to the BBSRC and Defence and Security Acceleratory Fund).

A bottom-up approach. Initiatives within the Division often develop from the ground up. For example, the Early Careers Challenges and Opportunities (ECHO) group was formed by Ph.D. students and post-docs to provide support in dealing with early-career demands. This group meets monthly, and prior to Covid-19 restrictions this was over a divisionally-funded lunch. Similarly, as developmental psychology has emerged as a strength, postgraduate students have been encouraged to lead the Scottish Developmental Psychology Network, an interdisciplinary network of students and early career researchers which hosts knowledge exchange and networking event for participants from multiple Scottish Universities. Finally, to foster leadership skills in early career staff, a member of the *Behaviour and Evolution* group founded the Stirling Crucible (modelled on a Royal Society of Edinburgh programme that provides 'a leadership and development programme for Scotland's research leaders of the future'). As described in the Institutional-level statement, Stirling's Crucible is now a University-wide programme that enhances skills and allows mixing with peers from different disciplines. Four cohorts of researchers - many from Psychology - have benefited to date.

Succession planning. A key component of our sustainability is in the provision of leadership opportunities, particularly for mid-career academics. This approach has facilitated leadership development within the Division with mid-career staff now in key roles such as of Deputy Heads, Head of Division, Chief Examiner, Ethics Chair, Equality and Inclusion Champion and Postgraduate Director. These changes have also allowed the Division to improve the gender balance in senior roles (five of these seven roles are filled by women), and to ensure the long-term sustainability of our leadership and research culture.

Technical and administrative support. The technical staff within the Psychology Division are key to our research and instructional success. They are led by the chief technician and feature expertise in mechanical and electrical systems and computing and I.T. systems. In turn, we support their development and visibility by providing well equipped electrical and computing workshops and by their participation in our Divisional meetings. The University has subscribed to the Technician Commitment, and in Psychology we encourage our technical staff to continue to develop their technical and (where desired) academic skills. Our IT Systems technician, for example, is pursuing his Ph.D. studies part-time within the Division. In the Divisional office, our research groups are supported by five outstanding administrative staff allowing academics to focus on research and

impact activities. Beyond this, the University provides central support for grant development, information technology and marketing/recruitment via dedicated offices for each.

Organisation and management: Each research group has a leader whose role is to provide oversight, direction and governance, and to serve on the Psychology Research Committee (led by Divisional Director of Research). The Psychology Research Committee meets monthly, with a remit to identify and address obstacles to research and to support research bids and Ph.D. student progress. In turn, the Divisional Director of Research is a member of the Faculty of Natural Science Research Committee (together with Biological Sciences, Computing Science and Maths, and Aquaculture), which meets monthly to develop, drive and embed progress within each Division and to implement the University's research strategy.

A key aim of the Divisional structure is to encourage innovation, ensuring that new developments fit local needs. For example, recent investment in functional near-infrared spectroscopy imaging equipment arose from proposals in *Cognition and Complex Environments* group, based on a desire to use neuroimaging in infants. Our local systems are enhanced by specialist support from the University Research and Innovation Services (RIS), which provides guidance and expertise in relation to policy and strategy, research ethics and governance, grant development and management of active grants. RIS also provide professional training and development – including external grant writing expertise and a range of local and online resources for all staff.

Postgraduate student support, training and supervision: Research postgraduate students are central to our research culture and 28 Ph.Ds. have been awarded by the Division during the past seven years. We support and develop our postgraduate students by providing individual funding (£2,250 per student for conference attendance and research expenses), delivering a dedicated bespoke training programme, providing a stimulating but supportive environment, and closely matching supervisors to nurture talent and to deliver high-quality research. In addition to this local support, the University provides support across the postgraduate community within its Institute of Advanced Studies. A fundamental goal of the Institute is to enhance the postgraduate experience by providing skills training and career assistance.

Features of these approaches are as follows:

As members of the Scottish Graduate School of Social Science and ESRC Doctoral Training Partnership, we attract students who are funded through the Psychology Pathway for 3 or 1+3 years. In addition, the University, Faculty and Division regularly funds studentships. Awards are made competitively through a process that requires candidates to seek external funding. This approach attracts high-quality applicants and successfully leverages external funds from multiple sources, including ESRC CASE awards, Carnegie Ph.D. Scholarships, Scottish Chief Scientist Office, ORS, HEA, the Leverhulme Trust and national and international charities. In addition, we have forged strong links with industry partners. . For example, two BBSRC CASE awards have been awarded in conjunction with partners at Unilever and AstraZeneca. The University has supported University Impact Studentships in Psychology, and a Faculty scheme offers matched research postgraduate awards, encouraging industrial, commercial or charitable partnerships., We also fund six bursaries for MSc students per year, which allows us to identify and encourage talent from our annual pool of MSc students to continue as research-based students. We have 148 MSc students currently (2019-2020 intake; 38 of which are in Health Psychology), and have purposefully developed specialist MSc pathways based on our research strengths in Child Development, Evolutionary Psychology, Cognition, Faces, Perception, Autism and Human-Animal Interactions.

Our Ph.D. students are drawn to study at Stirling from across the globe. We also host Ph.D. students from Europe as part of the ERASMUS exchange programme and as guests. For example, a Ph.D. student from Croatia who worked within a Division lab received the Kondic Memorial Award from the British Scholarship Trust in 2017 (awarded to the scholar who made the best use of their visit to the UK).

Our postgraduate students are provided with extensive training and support, guided by Vitae's Every Research Counts and Researcher Development Framework agendas, the employability

agenda set out by the University of Stirling (2011) and the Scottish Government imperatives on employability (2012). Formal training for postgraduate students is delivered at three levels: by the Division, through the university's dedicated Institute of Advanced Studies and through our membership of the ESRC's Doctoral Training Partnership (DTP) in Scotland.

The Division of Psychology provides postgraduates with training in research methods, including quantitative and qualitative techniques, as well as key 'Skills for Psychologists' (ethics; science communication; networking; impact; grant writing and reviewing). Membership of SINAPSE provides access to European network funding and regular training events in imaging methods including an annual scientific meeting; membership of the Scottish Primate Research Group allows our research postgraduate students access to primate research facilities in Edinburgh Zoo, including cognitive testing and attendance of professional meetings.

Within Psychology we encourage a supportive and active research environment by including postgraduates in all research group meetings, workshops, oral presentations and poster conferences. We organise dedicated postgraduate events, such as networking opportunities and peer lunches, to create a positive culture of engagement. Our postgraduates also have staff-level access to all facilities and support, which includes 4.9 FTE administrative and 4 FTE technical staff in Psychology, plus additional Faculty support staff. We also actively encourage postgraduates to engage with external collaborators and present at national and international conferences.

Supervision for each student is provided with at least two supervisors. Students work closely with their supervisors (with daily to bi-weekly meetings, depending on the project), and with progress and actions being recorded in an online log. Within Psychology the Research Committee directs formal staff-student consultations, and separate pastoral care and support is available independent of those responsible for assessment and progression via a Postgraduate Tutor plus an individually allocated Personal Tutor.

Annual progress appraisals are conducted by the Postgraduate Director and Director of Research. Progression to the 2nd year of Ph.D. study requires passing a formal 1st Year assessment, including a mini-viva to discuss a draft publication, modelled on a Ph.D. relevant paper. Subsequent years are also marked by formal annual progress reviews. We encourage publishing at postgraduate level, with the goal of having one or more papers in submission before graduation. Postgraduates typically present their research internally within the Division and Faculty and externally by the end of year two.

Section 3. Income, infrastructure and facilities

Income: In the REF period, the Division of Psychology has had notable success in attracting research income from diverse sources. Since 2014 our overall research income has nearly doubled. EU funding has risen from approximately £48k during the preceding REF period to over £770k in the current period, while charitable funding has increased more than ten-fold, from £35k to £364k, in the same period. Figure 3 illustrates the change in research income over the REF period (two year interval averages).

We have achieved funding growth by communicating University strategic expectations and aspirations to our research staff, implementing a rigorous internal peer-review process, providing training on funding application planning, increasing the level of mentoring of junior staff by experienced colleagues and through diversification of our target funders. We now receive income to support our research from multiple sources including:

- UK industry: Vasopharm GmbH; OYNB; Boots UK Ltd
- UK charities: The Carnegie Trust, The Leverhulme Trust and Wellcome Trust
- Research Councils: ESRC, EPSRC, BBSRC and NC3Rs
- Central Government: Academy of Medical Sciences, National Institute for Health Research, UK Office for Science
- European funding: Horizon 2020, German Research Foundation

- International sources: Bill & Melinda Gates Foundation; Protex.

Infrastructure and facilities: One of the unique features of the Division of Psychology at Stirling is our on-site **Kindergarten** (Figure 4). This facility underpins our research on how cognition develops. Within it, children have the opportunity to participate in numerous valuable research studies, and these provide enjoyment and learning opportunities beyond the standard early year's curriculum. This facility achieved an 'Excellent' rating in the most recent Care Inspectorate report (December 2018). The Kindergarten has been central to our research vision in the following ways:

- Enabling research on language and non-verbal communication (including comparative studies with non-human species), social learning, cognitive development, and the neural basis of executive function. Our research also includes comparative studies of children with autistic spectrum disorders and developmental delay.
- Providing research participants for five researchers specialising in developmental psychology who have joined the Division in the current REF period. Since 2014, developmental psychology studies have been supported by grants from the Jacob Foundation, the European Union, the Hardiman Fund and the Academy of Medical Sciences. Work in the kindergarten is reviewed by our ethics panel, and robust safeguarding procedures are in place for working with the children.
- Allowing interdisciplinary collaborations with researchers from Social Sciences, Primary Education and the Dementia Centre. For example, we have recently run an intergenerational project that brought people with dementia together with children in the Kindergarten.
- Providing a vital resource for undergraduate and postgraduate research experiences. Hundreds of postgraduate and undergraduate students have gained valuable research skills and ethical insights by developing and conducting research studies with our young cohort of willing participants, including up to 90 students of Primary Education each year.

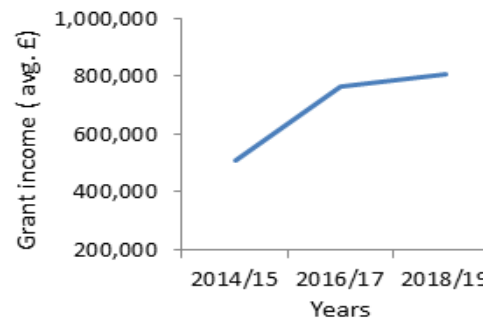


Figure 3: Division of Psychology research grant income



Figure 4: Psychology's unique Kindergarten allows interdisciplinary research on cognitive development.

The range of equipment used to study aspects of development extends from highly specialised apparatus to soft toys. We have also installed a child-specific eye-tracking suite adjacent to the Kindergarten. For research requiring functional neuroimaging we use mobile functional near-infrared spectroscopy equipment that enables child and infant monitoring in naturalistic settings and can accommodate multi-modal measurement including electroencephalogram (EEG), electromyogram (EMG) and eye-tracking. We have recently upgraded the facilities to include digital camcorders and digital sound recording via mobile head-mounted microphones.

The Division also features the **Psychological Imaging Lab**. This has been designed and equipped to promote neuroimaging research by members of the *Cognition and Complex Environments* research group, and houses three 64 Channel EEG recording suites. In addition, the recent acquisition of three mobile EEG and EMG recording systems and an fNIRs system allows

researchers to take their work outside the laboratory, promoting the strategic goal of increasing focus on real-world research. Examples of research conducted using mobile equipment include improving understanding of learning and development, spatial navigation, attention during real world behaviour, and a variety of sport-specific applications (recording neural activity during golf putting and shooting, funded by SportScotland, which manages Scottish elite athletes).

Our **Face Lab**, again within the *Cognition and Complex Environments* group, houses several researchers engaged in face research. Areas of interest range from individual differences, mechanisms of recognition and low-level visual procession – including the work that underpins the EvoFit impact case study - to gaze perception. It also includes social perception, the perceptions of attractiveness and mate preference. Equipped with both 2D and 3D photography suites, the lab has dedicated image-processing facilities, including bespoke software and tools developed by our in-house team of researchers and technicians. Having purchased a 3D camera, our staff then developed an integrated 3D camera system. Our technical team has also designed and built a bi-directional video system for direct full-face video recording of two people engaged in conversation. Recent purchases have included Eyelink and Tobii eye-trackers and both Dikablis Pro and Tobii mobile eye trackers. The lab also hosts an ESRC-funded database of face images, which are made available to face researchers via a website (pics.stir.ac.uk). Examples of output from research conducted in the Face Lab include findings on the importance of featural and configurational information in facial composite recognition, identification of individuals who excel at facial recognition (termed super-recognisers) and the discovery that state-of-the-art computer face recognition systems mistakenly match faces of different apparent race or gender.

Additional facilities include:

- The **Perception Lab** houses psychophysics equipment such as an integrated computerised psychophysics system (ViSaGe stimulus generators/ programmable hardware system), ultra-high-precision displays (Display++), high-precision photometry, Wheatstone stereoscopes, Augmented Reality (Microsoft HoloLens) and room-scale Virtual Reality (HTC Vive Pro, Oculus Rift) equipment. The availability of this capacity has led to an award from the UK Government Office for Science on deep-learning and depth-based image segmentation.
- The **Physiology Lab** houses computerised neuropsychological testing equipment CANTAB, treadmill for studying of physical activity, portable cardiovascular assessment apparatus that allows continuous assessment in 'real-world' environments of blood pressure, heart rate variability, cardiac output and peripheral resistance and cold-presser baths for studying pain perception.
- The **ConFace** lab adds to the Division's strength in facial research by identifying biomarkers of concealed recognition (via remote eye track, micro-expression detection, and mobile sensors for recording heart rate, skin conductance, and pulse and voice variation). Work here has identified the physical responses that occur when people lie about familiar faces (www.confce.org).
- The **Motor Action Lab** allows researchers to conduct locomotor assessments and neurostimulation, including Transcranial Direct Current Stimulation and Transcranial Magnetic Stimulation. This lab was key to the finding that sub-concussive changes in the brain occur as a result of football heading. This resulted in heightened public interest in the safety of football heading (Figure 5).

We also provide support for researchers via a range of external facilities, including through investment in national and international consortia:

- **Living Links** and the **Budongo Trail** facilities



Figure 5. Investment in the Division's Motor Action Lab since 2014 has led to high profile impact on brain health and concussions in sport, highlighted in the BBC documentary 'Alan Shearer: Dementia, Football and Me'.

housed at Edinburgh Zoo. Researchers in the *Behaviour and Evolution Research Group* are members of the Scottish Primate Research Group consortium, which in turn has partnered with the Royal Zoological Society of Scotland to form the Living Links / Budongo research Consortium. Partnership in the consortium facilitates research into behaviour and cognition of capuchins, squirrel monkeys and chimpanzees. An example of research using these facilities explored action-imitation abilities in capuchin monkeys (*Journal of Comparative Psychology*, 2017: tinyurl.com/ew3mtpnn).

- We continue to play an important role in **SINAPSE**, a Scottish Funding Council supported consortium of Scottish Universities that provides reciprocal access to imaging facilities, including fMRI, PET and SPECT molecular imaging, as well as training and networking events for all imaging researchers.
- We have a formal facilities agreement with an animal facility - the **Memory and Space Lab** - located within the Centre for Discovery Brain Sciences at the University of Edinburgh. This specialist facility allows a member of the *Cognition* group to conduct research involving single-unit electrophysiological recording in rats. This investment has led to funding from the BBSRC (two awards) and related outputs (e.g., which show, for example, that spatial navigation is underpinned by a representation of direction in the mammalian brain (*Current Biology*, 2017: tinyurl.com/5y59e5u6)).

In addition to these facilities, we also use existing resources in innovative ways to address research questions. For example, recent experiments using mobile EEG and eye-tracking took place in the University Library, investigating visual attention during a task involving the search and detection of books. Similarly, in our Kindergarten researchers often adapt simple everyday objects as stimuli. Our researchers and technical support staff take pride in delivering solutions to experiment requirements and we make targeted investments in facilities that are shared among researchers

Section 4. Collaboration and contribution to the research base, economy and society

In line with our core values, the Division of Psychology is highly collaborative. Since 2014, members of the *Behaviour and Evolution* and *Cognition and Complex Environments* have published extensively with collaborators from the UK and abroad, with 49% of our outputs involving international co-authors, 44% including UK collaborators and 39% included colleagues in the University of Stirling.

As described previously, the Division of Psychology is a key contributor to several of the University's discipline-crossing research programmes. For example, researchers in Psychology are members of the Contextual Learning in Humans and Machines programme, which seeks to understand the impact of adding context to computational and machine learning through neural networks. This collaboration between Psychology, Computing Science and Finance explores the impact that context has on decision-making related to financial investment. As a second example the focus on collaborative projects has had produced high profile outcomes, including the first evidence of electrophysiological and cognitive changes arising from routine heading of footballs, which achieved the highest ever University Altmetric score of 1445 (putting it in the 99.99th percentile of the >14 Million articles tracked; *EBioMedicine*, 2016: tinyurl.com/4zhx63n4). This research was conducted by Psychology researchers in the **Mobile Cognition** programme together with colleagues from the University of Stirling's Division of Sport (UoA 24) and the *Centre for Health and Behaviour Change* (UoA 3), and with the support of funding from the National Institute for Health Research.

We also have a strong track record of cross-disciplinary research between *Cognition* group and computer science via the interdisciplinary *Stirling Vision and Image Processing* (SVIP) group. Members of this group combine expertise in computational and mathematical signal/image processing, neuroscience, biological visual processing, psychology and remote sensing. Evidence of success in this approach is the recent award of funding by the UK Defences and Security Accelerator.

International outlook: At Stirling we actively encourage staff to collaborate internationally, and provide each academic with an annual, £1,000 personal discretionary fund that can be used to support research visits abroad. The locations of our international academic collaborators are illustrated Figure 6, restricted solely to collaborations that have produced outputs during the REF period. As a specific example of this, we have partnered with colleagues at the Max Planck Institute and UC Berkley in a longitudinal study of cognition and behaviour and related neural events measured through fMRI (*Psychological Science*, 2017: tinyurl.com/48pfhbaf).

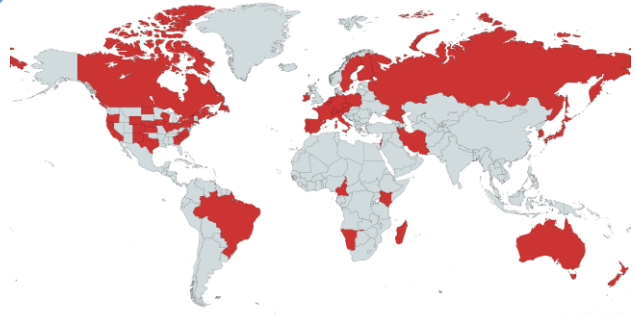


Figure 6. Locations of international collaborators producing published outputs from 2014-2020 (504 co-authors, in 129 locations, in 30 countries, including >20 US states).

National Collaborations: Closer to home, we have collaborations with over 60 institutions in the UK, as illustrated in Figure 7, which evidences our reach across UK academic institutions. The figure also highlights non-academic collaborators underpinning our impact activity, for example:

- Work in collaboration with the Scottish Prison Service on the *Paws for Progress* initiative to monitor the psychological and behavioural effects on offenders who participate in an assistance dog training programme. Members of *Behaviour and Evolution* provide their expertise in human-animal interaction and animal welfare, in academic collaboration with the School of Applied Social Science, who provide expertise in criminal justice and offender rehabilitation (*International Journal of Environmental Research and Public Health*, 2017: tinyurl.com/969fbtkk).
- Membership of the Scottish Primate Research Group, which includes six Principal Investigators from the University of Stirling. This group focuses on non-invasive studies of the natural behaviour, mentality and ecology of primates, with the aim of developing evidence-based welfare and conservation policies.

Examples of key impacts resulting from our research include:

- Changes in the European Convention for the Protection of Vertebrate Animals used in Experimental and other scientific purposes (ETS 123), and an associated directive. Commercial researchers involved in animal experimentation have welcomed the clear, evidence-based recommendations on animal welfare. For example, the Director of Policy and Outreach at the NC3Rs stated “*the positive welfare impact of this research by Buchanan-Smith and colleagues is thus far-reaching.*”

- Promotion of animal welfare is also supported by conducting seminars and workshops, and providing online resources to promote consideration of animal needs throughout their lifespan. For example, members of the *Behaviour and Evolution* group have produced knowledge-exchange websites including marmosetcare.com and 247animalwelfare.eu promote welfare of animals in zoos, laboratories and dog shelters. With NC3Rs funding, they also developed a teaching platform under the Refining Dog Care project (refiningdogcare.com).

- The *Stirling Human Animal Interaction Research* (SHAIR) group, established during this assessment period, has advanced understanding of how humans and animals interact, and developed new methodologies to evaluate interactions and promote positive outcomes. The flagship project is *Paws for Progress*, a programme for young male offenders involving dog training.

- A member of the *Behaviour and Evolution* group updated the NC3Rs guidelines leading to improvements in the housing and care of non-human primates (NHP) at UK universities and other publicly funded laboratories internationally. Requirements include providing increased space for animals, social housing and daily foraging opportunities – all of which are critical for NHP welfare.
- We impact on social policy at local and national levels, advising local education authority Quality Improvement Offices and Education Scotland policy makers.
- A member of the *Cognition* group advised Scottish MSPs and charity leaders on the impact of alcohol in adolescence, particularly the implications of blackouts in light of shift towards binge-drinking culture. Work from the *Cognition* group has led to consideration of the policies in relation to university 'freshers', to mitigate the effects of heavy marketing by alcohol retailers.
- Another member of the *Cognition* group advised the Scottish Parliament Justice Sub-Committee on Policing on how Police Scotland uses Facial Recognition technology. Our expertise contributed to an official report and a roadmap for future incorporation of live facial recognition technology.
- Ongoing research into facial composite imaging has resulted in the spinning out of EvoFIT, a suspect imaging and identification application in use by police forces and security organisations worldwide. The commercialisation of EvoFIT has been promoted in partnership with researchers at the University of Central Lancashire.

We are also regularly active in public engagement activities:

- We participate regularly in outreach events at the Glasgow Science Centre, at the Edinburgh Science Festival, at Living Links in the Edinburgh Zoo, and at the Dundee Science Centre.
- We encouraged participation and recruit research participants at outreach events, including regular events at Edinburgh Zoo.



Figure 7. Location and nature of collaborations in this assessment period.

- In order to engage with the widest audience possible, we have taken part in Bright Club comedy nights, ScienceGrrl, Pint of Science and Soapbox Science public engagement events.

We have also engaged in learned events:

- Events promoting animal welfare, including keynote addresses at the International Conference on Environmental Enrichment in Japan (2019), the inaugural meeting of the Great Ape Welfare Group and The Laboratory Animal Veterinarian Association (2018) and an invited presentation to the Animal in Science Committee of the Home Office in 2017. Other invited talks include one at the Primate Society of Great Britain's 50th anniversary meeting (2017).
- Recent plenary addresses have been delivered at the inaugural conference of the Cultural Evolution Society (2017) and the International Society for Human Ethology (2019), at the International Society for the Study of Women's Sexual Health (2018) and the Contraceptive Conundrum Conference (2015), and at the Royal Institute of Navigation International Conference (2019).
- Our researchers are regularly invited as speakers at international conferences including meetings in Argentina, Canada, Denmark, Italy, Netherlands, Poland, Romania, South Korea and the United States.

We recognise the vital role played by participation in the peer review process in upholding high standards of scientific endeavour, and therefore contribute to reviews of funding agencies and other scientific bodies, including:

- BBSRC Animal Sciences Grant Review Board member (Donaldson; Dudchenko)
- European Commission Horizons 2020 review and award panels (Ietswaart)
- QAA Benchmark review group member (Donaldson)
- Founder member of the BPS Impact review group (Donaldson)
- Research Assessor for the Carnegie Trust for the Universities of Scotland (Caldwell, Donaldson)
- Royal Zoological Society of Scotland member of Animal Welfare group (Buchanan-Smith)
- Living Links Executive Board member (Caldwell, Buchanan-Smith)
- Primate Society of Great Britain Captive Care Working Party member (Buchanan-Smith)
- IUCN Species Survival Commission Primate Group member (Buchanan-Smith)
- Primate Society of Great Britain Research Working Party member (Kessler)

Our research staff conduct editorial roles at numerous peer-reviewed publications, including:

- Applied Cognitive Psychology and Network: Computation In Neural Systems, Editorial board member (Hancock)
- American Journal of Primatology, Editorial board member (Vick)
- Biology Letters, Editorial board member (Caldwell)
- Evolutionary Psychology, Associate Editor (Caldwell)
- Autism in Adulthood, Deputy Editor (Cage)
- Frontiers in Theoretical and Philosophical Psychology, Associate Editor (Kourtis)
- Frontiers in Psychology, Associate Editor (Gheorghiu)
- Frontiers in Human Neuroscience, Associate Editor (Ietswaart)
- Neotropical Primates, Editorial board member (Buchanan-Smith)
- Philosophical Transactions of the Royal Society B, Guest Editor (Roberts)
- European Journal of Neuroscience, Guest Editor (Keitel)
- Primates, Associate Editor (P. Lee)

Our staff are office holders of learned societies and scientific institutions, including:

- International Society for Human Ethology, current president, past vice-president (Roberts)

- European Science Foundation's College of Expert Reviewers, invited member (Roberts)
- Association of Heads of Psychology Departments, Chair (Donaldson)
- Scottish & NI Hub of Vitae, steering committee member (Donaldson)
- Amboseli Elephant Research Project, Director of Science (P. Lee)
- Royal Society of Edinburgh's Young Academy of Scotland, member (Caldwell)
- Royal Society of Edinburgh, Fellow (Watt)
- British Neuropsychological Society (Ietswaart)

Other awards and fellowships for our staff have included:

- Leverhulme Early Career Fellowship (Bobak)
- Primate Society of Great Britain Osman Hill medal (Buchanan-Smith)
- The Council for Science and Animal Welfare award from AstraZeneca (Buchanan-Smith)
- British Academy Mid-Career Fellowship (Roberts)

We have hosted International scientific events, including:

- Royal Society Theo Murphy International Scientific Meeting on Human Chemical Communication, Organiser, 2019 (Roberts)
- 23rd Biennial Congress of International Society for Human, Host, 2016 (Roberts)

Conclusion: As the evidence above indicates, the Division of Psychology's research reaches a wide range of beneficiaries, ranging from offenders to law-enforcement organisations, from robust athletes to those in poor health, from new-borns and infants to students of all ages, and from animals in captivity to custodians of wildlife. What makes Stirling distinct – our expertise in facial recognition research, cumulative culture task development and mobile cognition – produces a recognised contribution to the research base both in the UK and internationally. This includes not only outputs, but also leadership of scientific societies, organisation of international meetings and participation in editorial boards and grant panels. Going forward, the Division's strategy is to develop our early- and mid-career staff and enhance strengths in childhood development, in interactions between humans, animals, and robots, and in brain-mobility relationships. In this way, the Division of Psychology will continue to deliver significant, tangible contributions to the field and to society.