REF2021

Institution: Lancaster University

Unit of Assessment: 4, Psychology, Psychiatry and Neuroscience

1. Unit context and structure, research and impact strategy

1.1 Overview
We are 39 (FTE=35) staff in the Department of Psychology, within the Faculty of Science and Technology at Lancaster University. Our research is conducted through four focused research groups: **Infancy and Early Development**, **Language and Cognition**, **Perception and Action**, and **Social Processes**. Since 2014, we have transformed the capacity and the quality of our research and impact activities. We have increased our Teaching and Research (T&R, Category A) staff by 40% (from 25 FTE in REF2014 to 35) with a commensurate increase in our PGR students (from 44 to 63 completions). We have more than doubled our research income (from £4.6M in REF2014 to £12.7M) placing us in the top 14% UoA4 groups for funding per-FTE. We have enhanced the academic impact of our work (number of top-10 cited publications in their fields increased by over 50% from 70 to 110, 19% of our publications, source: SciVal). We have developed 62 funded projects with stakeholders from charities, industry, education, health, and government bodies.

1.2 Unit context and structure
Our four research groups provide critical mass of expertise, and play a leading role in university-wide, national, and international research and impact networks (see Figure 1). This is attested to by our leadership and involvement in three ESRC research Centres (LuCiD, CASS, CREST), and through our impact on policy and practice as evidenced in our Impact Case studies with business (**Sünram-Lea**), government (**Taylor**), health, and education (**Cain**). At the heart of our research environment is a cooperative and interactive research culture that maximises sharing of skills and infrastructure resources, with a fundamental commitment to supporting career development. This is evidenced by future research leader grants and fellowships for Early Career Researchers (ECRs) across the research groups (e.g., **Dunn, Hartley, Nuttall**).

Our four research groups are:

Infancy and Early Development (**Alcock, Bremner, Dunn, Hartley, Lewis, Parise, Reid, Westermann**)*.* This group utilises multi-method approaches (neurophysiological, behavioural, and computational) to investigate cognitive and social development from prenatal to school age, in typical and atypical populations. The group's multi-method approach includes a strong commitment to training future research leaders in developmental research: **Westermann** leads the £1.05M Leverhulme Doctoral Scholarship Programme (DSP) in Interdisciplinary Research on Infant Development, training 21 PhD students. Innovation in methods resulted in **Dunn** and **Reid**'s (2017 *Current Biology*) discovery that pre-natal infants were sensitive to visual face-like stimuli projected through the uterine wall, a study that received >1 billion popular press readers worldwide. A highlight of our work on atypical development emerged from **Hartley**'s ESRC Future Leaders grant discovering that word learning mechanisms in children with autism were operational, but slower, than for typically developing children (2019 *Cognition*), work that is feeding into development of interventions to promote language development for children with autism.

Language and Cognition (**Beesley, Cain, Citron, Connell, Davies, Groen, Hurlstone, Lynott, Monaghan, Towse**)*.* The group investigates language at multiple levels from processing phonemes to advanced literacy throughout the lifespan, and cognitive processes relating to behavioural regulation, numeracy development, and embodied cognition. A central aim of the group is to examine variation and change of the individuals' trajectory of learning and cognitive skills, alongside exploration of the rich representational variation that occurs within language structures. This perspective underlies **Connell**'s £1.6M EU ERC project, leading to **Connell** and **Lynott**'s (2019 *Behavior Research Methods*) discovery that individual words invoke multiple sensory experiences, and **Cain**'s (2017 *Journal of Educational Psychology*) finding that there are

predictable pressure point discontinuities in literacy development resulting from cognitive constraints, shown to affect reading even in later life by **Davies** (2017 *Journal of Experimental Psychology: Learning, Memory and Cognition*).

Perception and Action (**Braithwaite, Crawford, Lew, Linkenauger, May, Nuttall, Plack, Sünram-Lea, To, Vogt, Walker, Wang**)*.* The group's work combines techniques in advanced human brain stimulation, psychophysiology, neurophysiology, neuroimaging, virtual reality methods, and computational modelling. This expertise in cutting-edge methods has resulted in discoveries including **Linkenauger**'s (2015 *Journal of Experimental Psychology: General*) finding that distortions of self-perception of size occur when comparing body parts but not when comparisons are to external objects, and **Plack**'s (2019 *Trends in Hearing*) combination of electrophysiological and behavioural methods to dissociate effects of ageing from those of noise exposure to understand adult hearing loss. **Crawford**'s work on neurodegeneration as co-director of the University's Centre for Ageing Research, led to his (2016 *Neuropsychologia*) work on fractionation of symptomatology in early-onset Alzheimer's Disease patients.

Social Processes (**Boyd, Conchie, Levine, McLatchie, Piazza, Power, Rakic, Taylor, Warmelink**). This group works on the social psychology of pro-social and anti-social behaviour, moral and high-risk decision-making, and security and trust. The group draws on the novel application of technology and computational social science, analysing behavioural, linguistic and visual digital data from smartphones and other wearable devices, social media and other online repositories, CCTV and other visual data sources. Key contributions to knowledge include **Power**'s (2015 *Journal of Applied Psychology*) work on decision-making under uncertainty in emergency response to critical incidents, which led to her Margaret Mead Award for Social Sciences (2019). The group's approach to big-data in social processes is illustrated by **Boyd**'s (2020 *Nature Communications*) work, which shows how emotional language use provides a window into psychological well-being, as well as enabling profiling of political and historical figures, and **Levine**'s (2019 *American Psychologist*) analysis of CCTV footage showing, across different countries, that people are likely to help those in distress in public places rather than be bystanders.
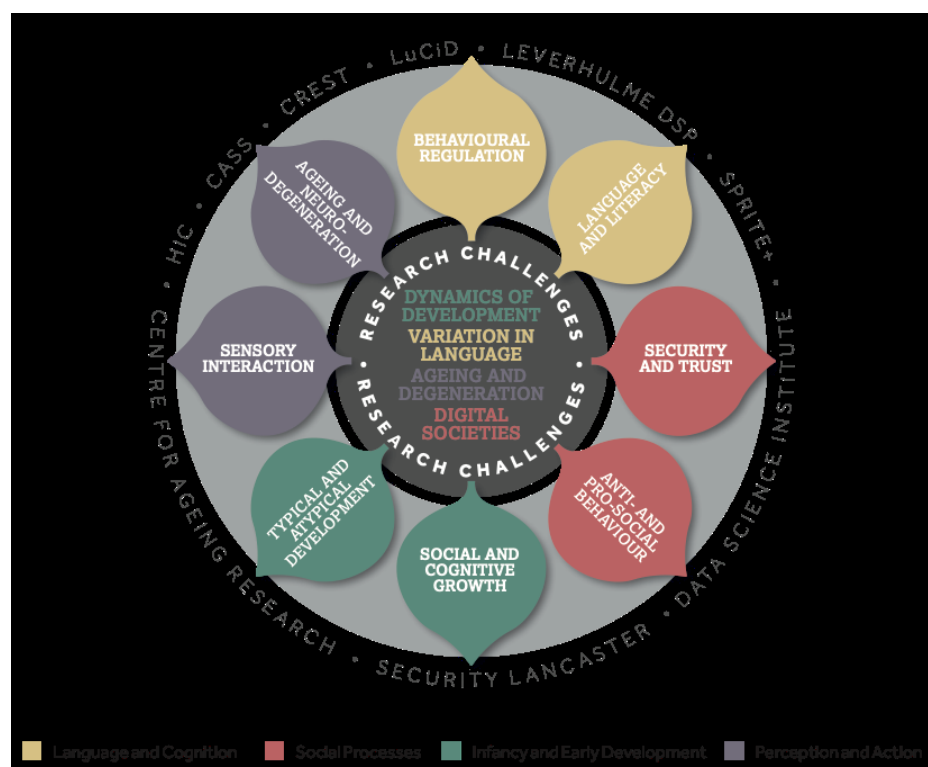

Figure 1. Research groups with key research themes, research challenges, and their interaction with University and national/international research organisations.

Fundamental to our research groups is their collaboration across disciplinary boundaries, each group playing key roles in three of Lancaster University's interdisciplinary research organisations:

- Security Lancaster (co-founded by **Taylor**, links to *Social Processes*, *Language and Cognition* research groups), combining researchers in computer science, linguistics, and psychology to address the way that individuals, organisations and societies secure and protect themselves;
- The Centre for Ageing Research (co-directed by **Crawford**, links to *Perception and Action*, *Language and Cognition*), combining researchers across the human sciences (e.g., health, biology, psychology) with computer science and engineering to address regional, national, and international challenges around quality of life in ageing populations;
- The Data Science Institute (links to all four research groups), drawing together quantitative, health, and social sciences with arts and humanities researchers to address contemporary topics in data-driven research.

Our research groups lead and/or contribute to three major ESRC Research Centres:

- The ESRC International Centre for Language and Communicative Development (LuCiD, 2014-2024, total funding £9.5M, £2.3M to Lancaster, co-directed by **Monaghan** (2014-2019), and **Westermann** (2019-2024), co-investigators: **Alcock**, **Cain**, **Parise**, **Reid,** links to *Infancy and Early Development, Language and Cognition*) is a collaboration between Lancaster, Manchester and Liverpool Universities that leads interdisciplinary research in child communicative development across psychology, linguistics, computer science, and education, with regular seminars, research meetings, skill training workshops, and impact events (including NHS representatives, and National Literacy Trust and iCAN charities as external partners). LuCiD also includes Kidd (Australian National University), Christiansen (Cornell), Elman (UCSD, to 2019), Krajewski (Warsaw), Leonard (Purdue), McMurray (Iowa), Rowe (Harvard), Rowland (MPI Nijmegen), Stoll (Zurich), and Tomasello (MPI Leipzig) as international collaborators;
- The Centre for Research and Evidence on Security Threats (CREST, 2015-2023, total funding £11.8M, directed by **Taylor**, co-investigators: **Boyd**, **Conchie**, **Power**, and **Warmelink,** links to *Social Processes, Language and Cognition*) is a collaboration between the Universities of Lancaster, Bath, and Portsmouth that examines national security and regularly commissions research from expert groups across the UK. CREST connects psychology researchers across the UK by providing regular competitive bid funding opportunities, communications, and collaborations. CREST dovetails with Lancaster University's EPSRC-NCSC Academic Centre of Excellence in Cyber-Security;
- The Centre for Corpus Analysis in the Social Sciences (CASS, 2013-2023, total funding £3.8M, co-investigator **Cain,** links to *Language and Cognition*) applies corpus analysis techniques across the social sciences. CASS organises regular meetings, workshops, and training events for collaborative research.

1.3 Research and impact strategy

Over the REF period, our strategy for driving forward our capacity for internationally-leading research and impact was structured around four pillars:

1.3.1 Extend capacity for highest-quality research in key areas of strength
We have accomplished this through the following strategically-driven actions:

- We restructured from two to four research groups. This gave us greater focus and visibility for our areas of research strength, allowing us to expand staff but maintain an optimal group size for maximising communication and interactivity;
- When increasing our T&R staffing, we sought appointments that maintained balance among the research groups, expanding expertise in novel, complementary skills primarily through the appointment of ECR staff (9 current staff joined us in their first T&R post since 2014). We also ensured groups contained senior leadership to support and mentor ECRs;

- Our appointment strategy focused on T&R posts, rather than teaching-only positions, to maximise our research capacity. We are sector-leading in our high proportion of T&R staff (see Section 2);
- We supported the development of large-scale funded research initiatives through our research groups' coherence and vision, supported by University Research Support services. Consequently, success in large-scale interdisciplinary research programmes has increased (i.e., three ESRC Centres, the Leverhulme DSP, and several EU ERC and ITN projects, see Figure 1, and Section 3). Our research income (see Section 3) and quantity and academic impact of our papers have more than doubled (see Section 4).

1.3.2 Expand our use of cutting-edge methods

We have focused on developing cutting-edge techniques that are sustainable in the long-term within a medium-sized Department. In the REF period, we substantially improved our facilities infrastructure through the following initiatives:

- Our new T&R posts consolidated our core expertise and expanded the range of methods we utilise across all four research groups, e.g., **Braithwaite** (tDCS), **Boyd**, **Levine**, **Wang** (large scale behavioural analysis), **Dunn** (4D ultrasound), **Groen** (EEG), **May** (neuron-level computational neuroscience), and **Nuttall** (TMS);
- We integrated and extended our research facilities (see Section 3). We have new, bespoke facilities for psychological research in a dedicated two-storey research building containing infrastructure for integrated multi-method studies (see Section 3);
- We implemented an inclusive approach to research skills and facilities for all researchers at every career stage. All our labs are accessible to any trained researchers to ensure maximal use of facilities according to need.

As a consequence of this expansion in methods, 72% of our publications link psychology with multiple disciplines (see Figure 2), we have breadth in our grant success with **84% of all T&R staff, and 93% of ECRs obtaining funding** (see Section 2), and access to a wide range of grant funding sources – 213 projects from 63 different funders (see Section 3, and Figure 4).
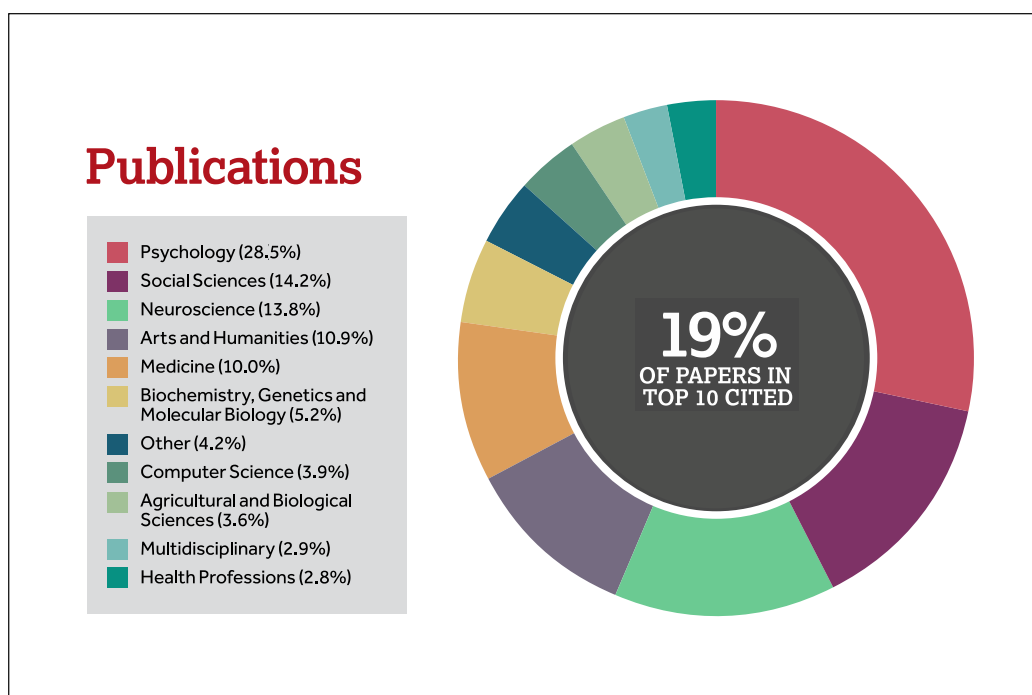

Publications

- Psychology (28.5%)
- Social Sciences (14.2%)
- Neuroscience (13.8%)
- Arts and Humanities (10.9%)
- Medicine (10.0%)
- Biochemistry, Genetics and Molecular Biology (5.2%)
- Other (4.2%)
- Computer Science (3.9%)
- Agricultural and Biological Sciences (3.6%)
- Multidisciplinary (2.9%)
- Health Professions (2.8%)

19% OF PAPERS IN TOP 10 CITED

Figure 2. Our publication profile: Percentages of papers by primary discipline.

1.3.3 Expand our PGR student population

To support research growth, expand our impact, and sustain the discipline by training future research leaders, we expanded our PGR numbers by 43% from 44 in REF2014 to 63 completions. We achieved this by:

- Maintaining our current successful routes for funding, by training staff in supporting ESRC PhD applications. We obtained 11 studentships from our usual studentship pathway, the ESRC North West Social Sciences Doctoral Training Partnership (NWSSDTP);
- Focusing on diversifying our portfolio of funders for research studentships by supporting staff to apply for non-traditional forms of funding. We did this through workshop training and networking opportunity events with external bodies. We obtained studentships funded by DSTL, NHS, and industry partners, and co-funding for 3 ESRC/EPSRC case studentships;
- Prioritising applications to large centre grants with associated studentships, and doctoral training programmes. We participate in 3 EU ITNs (3 studentships), 11 studentships are associated with the ESRC research Centres, and 21 studentships within the Leverhulme DSP;
- Investing a large proportion of our QR-sourced income by creating 20 studentships;
- Retaining and supporting PGR students with bespoke training, involvement in all aspects of the department's functioning, and regular monitoring for academic and pastoral support (see Section 2). Consequently, **100% of our PGR students complete on time** (see Section 2).

1.3.4 Increase engagement with stakeholders
Each research group is committed to formalise involvement of stakeholders in research. This is achieved through the Department's Impact Officer, who identifies new opportunities for impact, and the Faculty Impact Manager who facilitates stakeholder collaborations, including business engagement partners operating in the Faculty and in the University's £41M Health Innovation Campus (see Section 4 for more details).

We have achieved increased engagement through:

- Strategic appointments that have developed new links with industry partners through our use of language analysis (**Boyd**), Department for Transport through the uses of CCTV data (**Levine**), and the emergency services through work on decision-inertia (**Power**);
- Using the established networks in the University interdisciplinary research organisations, and the ESRC research Centres (see Section 4);
- Developing new networks of researchers through business engagement partners operating in the Faculty of Science and Technology and the Health Innovation Campus. For example, the EPSRC funded Security, Privacy, Identity and Trust Engagement NetworkPlus (SPRITE+ 2019-2023, total funding £1.4M, co-directed by **Conchie**, co-investigators: **Levine**, **Taylor**, **Towse**) links Lancaster, Imperial, Manchester, Queens Belfast, Southampton and Hanyang Universities and multiple stakeholders (see Section 4) to identify key national and international priorities for interdisciplinary research in digital security and privacy.

As a consequence, we have received funding with stakeholders for 28 charity projects, 14 industry projects, and 20 local and national government and NHS projects.

1.4 Future research and impact strategy
Each of our four research groups is taking on a central research and impact challenge to address over the next five years (see Figure 1):

- *Infancy and Early Development* addresses **dynamics in development**, exploiting our recent advances in pre-natal behavioural studies to determine how interactions between social and cognitive development prior to birth extend throughout childhood;
- *Language and Cognition* builds on our examination of cognitive and behavioural **variation in language** learners and language systems to determine how best to support individual language development;

- *Perception and Action* extends our portfolio of work on understanding and coping with changes in auditory and visual perceptual processing associated with **ageing and neurodegeneration**, addressing how we can improve quality of life for older people;
- *Social Processes* examines how we ensure that emerging technologies (for communication, surveillance, automation, leisure, and health) provide benefits within a **digital society**.

In spite of the recent Covid-19 pandemic, our community has remained active and resilient and we are confident that we can achieve our goals. We will meet each challenge by further enhancing the quality, range, and interdisciplinarity of our work. Our strategy incorporates eight aims, five addressing our approach to research, and three addressing impact generation.

1.4.1 Theory-driven interdisciplinary research
We will take on these challenges by developing our theory-driven approach to the social and cognitive sciences, harnessing innovations in availability and analysis of large-scale, multi-source data, coupled with laboratory-based behavioural and neuroscientific studies. We will use our embedded interdisciplinary collaborations and increase our use of new technologies and data analysis techniques. We envisage the challenges of the *Infancy and Early Development* and *Language and Cognition* groups to coordinate closely with LuCiD, CASS, and the Data Science Institute, *Perception and Action* to work with the Centre for Ageing Research and the University's Health Innovation Campus initiative (see 1.4.8 below), and the *Social Processes* group to work with CREST, Security Lancaster, the SPRITE+ network, and the Data Science Institute.

1.4.2 Transitioning Centres into sustainable long-term centres of national excellence
The three ESRC Centres to which we contribute are fundamental to meeting our research challenges. These Centres are now in continued periods of funding. The momentum of research and impact of these Centres will be advanced by pursuing joint-funded projects with our partners (see Sections 3 and 4 for examples of current activities); ensuring our facilities are future-proofed to enable continued work with stakeholders (e.g., £1.4M investment in secure data science infrastructure, Section 1.4.7 below); and leading networking and dissemination events that draw researchers and non-academics together to highlight research priorities across a variety of constituencies (see Section 4 for examples of outreach events organised).

1.4.3 Being at the vanguard of open science and research integrity
In January 2017, we launched the first psychology open science group in the UK (PROSPR), now part of the recently formed UK Reproducibility Network and the network of UK Open Science Working Groups. PROSPR aligned us with open, reproducible scientific practices, and we regularly contribute to large-scale studies and multi-lab replications (see Section 4 for more details of our open science contributions).

We will continue to lead open science practice and research integrity, embedding this across multiple disciplines through our collaborative networks. We will accomplish this by advocating open science into the University's ethical approval process, extending our regular Departmental open science meetings to University-wide workshops, and increasing our participation in replication and multi-lab data collection studies. We aim to achieve 100% compliance with open science practices within the next 5 years.

1.4.4 Developing people
Nine of our current staff joined us since 2013 for their first T&R post. A key strategic aim is to provide the support and structures that will enable these ECRs to fulfil their potential for world-leading research. We will accomplish this through our system of mentorship that supports individual development needs, and research group membership that includes ECRs into calls for funding and shares skills in our collaborative, open culture. See Section 2 for details of our staff development and support strategy and mechanisms.

1.4.5 Developing resources and infrastructure

We will ensure our cutting-edge research facilities are continuously updated, with long-term commitments by the University to maintain our current bespoke research building and associated space. Our culture of resource sharing and skills training will maximise utilisation and development of our facilities (see Section 3). We are aligned with University infrastructure initiatives such as the Health Innovation Campus development, which involves the Centre for Ageing Research, ensuring progress for our interdisciplinary collaborations with health sciences.

Our **future impact strategy** will ensure that our work has maximum transfer to end-users. In addition to our ongoing activity, we will:

1.4.6 Increase opportunities for co-development of research with stakeholders
We will build on our previous success through applications to impact acceleration accounts, business consultancy roles, CASE studentships, placements, and secondments (e.g., CREST's Research-to-Practice fellows, see Section 4), to extend our profile of joint-funded research.

1.4.7 Developing infrastructure
We will develop our facilities to ensure that we meet stringent requirements for collaborations with industry and government bodies, such as CREST's £1.4M funding for secure data science infrastructure to meet industry and government standards.

1.4.8 Contributing to health, education and wellbeing in the North West
We will actively participate in the strategy boards for the University's £41M Health Innovation Campus and the proposed £110M Eden Project North. These initiatives will provide access to a broader network of stakeholders for collaborative research and community dissemination (see Section 4).

2. People

2.1 Staffing strategy
Our strategy for people in the Department is to appoint, support, and develop staff to reach excellence in all areas of their academic service. We focused on recruiting a diverse range of world-leading researchers primarily in early career stages (70% of appointments were ECRs), to consolidate and extend our research groups' capacity. We coupled this with staff development to retain staff and support promotions to senior roles.

In this REF period, our 40% staff expansion has been underpinned by strategies enhancing equality and diversity. We have made improvements to gender balance by role, increased proportion of BAME T&R staff (see Figure 3), and maintained our proportion of staff with a declared disability at 8% of staff (7% in 2013). The age profile of our staff has changed substantially, with 42% of staff under 40 years (14% in 2013).
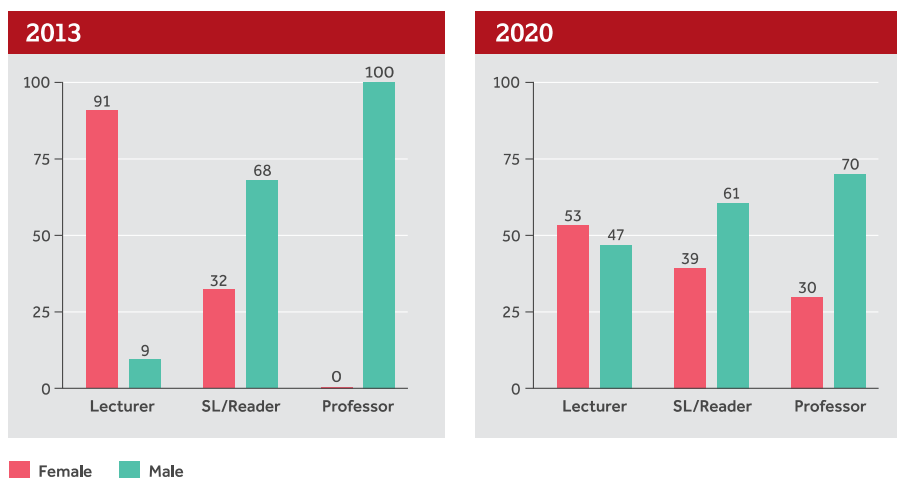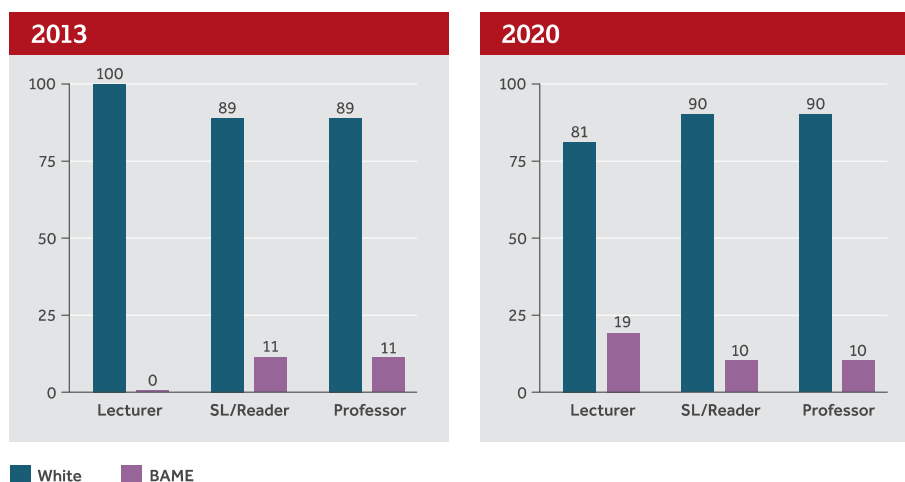
Percentage of female and male members of staff at each grade level:

2013	2020

Figure: Bar charts showing percentage of Female and Male staff.

2013:
- Lecturer: Female 91, Male 9
- SL/Reader: Female 32, Male 68
- Professor: Female 0, Male 100

2020:
- Lecturer: Female 53, Male 47
- SL/Reader: Female 39, Male 61
- Professor: Female 30, Male 70

Legend: Female, Male

Percentage of white/BAME members of staff at each grade level:

2013	2020

Figure: Bar charts showing percentage of White and BAME staff.

2013:
- Lecturer: White 100, BAME 0
- SL/Reader: White 89, BAME 11
- Professor: White 89, BAME 11

2020:
- Lecturer: White 81, BAME 19
- SL/Reader: White 90, BAME 10
- Professor: White 90, BAME 10

Legend: White, BAME

Figure 3. Percentage of staff by academic role by gender and ethnicity (of those who declared ethnicity) in 2013 and 2020.

Our staffing strategy is dedicated to ensuring that staff are supported at all stages of their career, with a particular focus on ECRs, whilst also ensuring equality, diversity, and inclusion in all our practices. During this REF period, we have been successful in ensuring ECRs develop their own independent and integrated research agendas (93% of ECRs have gained funding) and constructing successful promotion cases (100% success for ECRs).

We have improved the balance of early career and senior staff largely through internal promotions (24 successful T&R promotions) which also improved our gender balance across roles (see Figure 3), with 54% of promotions for female staff. Succession planning is integrated into our Department structures, with all senior roles supported by a shadowing position.

An important aspect of our culture is that most staff are engaged in research and teaching, as mutually inspiring activities. 92% of our teaching staff are on T&R contracts (compared to 76% across the sector, 71% in Russell Group). Staff are only employed on teaching-only contracts as an unavoidable exception (e.g., to cover short-term changes in staff numbers due to temporary reduction in FTE or parental leave). Staff appointed to teaching-only contracts are supported via mentoring and research collaborations to achieve positions including research, and 100% of our previous fixed-term teaching-only staff have progressed to T&R or academic research-only posts.

2.2 Staff development

2.2.1 Staff support mechanisms
Our success is underwritten by multiple support mechanisms designed to develop staff at all levels of career, from postgraduate to professor. Each staff member (T&R and research only staff) is assigned three senior members of staff to support them: a line manager, a research group lead, and a mentor.

Line management. The Head of Department has oversight and overall responsibility for staff in the Department. Work is allocated according to a transparent workload model, to which all staff have access. To ensure that each member of staff has detailed attention to her or his needs and career development, line management is delegated to senior staff who manage approximately 8 staff each, and who meet regularly as the Department's Academic Development Group to provide oversight of training and support, workload allocations, and promotions. Research only staff are line managed by the Principal Investigator on their grant. Line managers conduct the annual performance development review (PDR) with staff, develop promotion cases, and ensure that staff are supported in all their activities. The PDR is a cooperative framework by which achievements are recognised, short- and long-term goals and barriers to achieve potential are discussed, and training support needs identified. Central to PDRs is attention to the University promotion criteria and identification of roles that permit demonstration of leadership. The PDR is followed up after 6 months to ensure that it is an active rather than merely a benchmarking process. 100% of staff complete the PDR, 85% report it as useful (42% in 2014), and 96% report agreement of clear objectives resulting from the PDR (65% in 2014).

Research group leadership. Research leadership is separated from line management to ensure a focus on support for research and impact of each staff member. Research groups provide a forum for discussion, elaboration, and tuning of research papers, grant applications, and impact plans. A consequence of this dedicated research support for staff has resulted in 84% of T&R staff gaining funding since 2013, diversifying our range of funders from 23 in REF2014 to 63 in the current REF period (see Section 3).

Mentorship. Each member of staff is appointed a mentor during their probationary period (either within or outside the Department), for an additional perspective on development plans, discussion of potential barriers, and support for well-being. Additional mentoring is available to staff in a University-wide scheme to support leadership skill development, and management of career transitions, such as returning from family-related leave.

Evidence of the success of these support mechanisms are the 24 successful promotions (89% of cases) in the REF period (see Figure 4).

2.2.2 Early career staff support
For new appointments, several mechanisms support effective establishment of research and impact activities:
- We ensure that all staff arriving in the Department are provided with the laboratory facilities needed to conduct the very best research in their specialism (see Section 3). During the REF period, £212K was dedicated to facilities for new staff;
- New T&R appointments are given additional time to support the establishment of their research programme at Lancaster (time dedicated to research activities: year 1 60%,

year 2 50%, year 3 40%), resulting in all ECRs applying for research funding (with 93% successful);

- Duties given to ECR staff are overseen by mentor, research group lead, and line manager. Additional support for goals are identified early in regular meetings and via biannual progress reports;
- ECRs are prioritised in terms of provision of PhD studentships (86% of our ECRs supervise PhD student(s)). ECRs receive a larger annual stipend from the Department than other staff to support participant payment and conference attendance;
- ECRs are incrementally provided with positions of responsibility so that they can develop toward eventual leadership roles. For complex roles (e.g., directors of the Department's committees), positions are initially in a shadowing role so that effective guidance is provided;
- ECRs are represented on all Department committees, and we host dedicated discussion and training events for ECRs (e.g., recent bespoke events on fellowship application and grant writing, and developing impact from research).

For our 68 research staff appointments on grants, we have dedicated policies in accordance with the Concordat to Support the Career Development of Researchers. All research staff (excepting those appointed for temporary cover of absences) are now appointed on indefinite (rather than fixed-term) contracts to ensure equal employment rights for all staff, comprising 82% of our current research-only staff. We regularly appraise and regrade staff roles using HERA job-evaluation criteria. Research staff have full access to all University training courses, as well as dedicated research staff events for grant writing, paper writing, and career development. Research staff may attend all academic staff meetings and events, and are represented on all Department committees. In addition to line manager and mentor, research staff can consult the Head of Department over any issues relating to management.

2.2.3 Resource provision
Research facilities and resources for all staff are regularly appraised to ensure that all staff have the environment they require to conduct excellent research and develop impact activities, from equipment and standardised tests, to space and testing resources. In addition to facilities provided by grants, staff contribute bids for new facilities on an annual basis to Faculty funds, and for pump-priming funds for research and impact on a 3-monthly basis.

2.2.4 Investment and recognition for research and impact
All T&R staff are allocated a minimum 30% of their time in workload for research and impact activities. Additional time is then provided for funded research activities, and through investment in staff developing strategically valuable research or impact projects. Additional time is allocated to those with identified impact cases, to develop, refine and collect supportive evidence.

The University offers Academic Research and Education Leave (AREL, i.e., sabbaticals) to academic staff on indefinite contracts on a revolving basis. In the REF period, 20 staff have taken AREL averaging 12 months duration. We use AREL to support development of large research initiatives, and transitioning ECRs to independent research programmes. We provide cover to enable reduced teaching and administrative loads for staff returning after family-related leave. For instance, research leave has directly resulted in success for **Connell**'s £1.6M ERC grant, **Cain**'s involvement as a Principal Investigator in the $10M continuation of the NIH Language and Reading Research Consortium longitudinal study, and **Westermann**'s £1.05M Leverhulme DSP.

Timetabling of teaching and administrative duties is organised as far as possible to provide space in the year for staff to focus on research and impact, and line managers respond flexibly to the individual needs and wishes of staff in terms of preserving blocks for research and impact time.

The University recognises research *and* impact activities in promotion criteria and internal staff awards, and contributions in these areas have supported all successful promotion cases from our staff during the REF period.

2.2.5 A culture of support

A culture of staff wellbeing and development applies to all staff in the Department. In reflection of outstanding performance, our professional services teams have received recognition from Faculty Awards: infancy and child development lab administrator (2018), student employability team (2018), recruitment administrator (2018); and one of our technicians won the BPS Technical Support in Psychological Research Award (2018).

2.3 Training and supervision of postgraduate research (PGR) students

During the REF period, 63 PhD students have completed, with a further 54 in progress. Our success in supporting **100% of our PGR students to complete on-time** (within 4 years FTE) was achieved through a range of support and monitoring mechanisms, but also by ensuring that PGR students are fully integrated into the Department in all meetings and processes, in recognition of their fundamental importance in enriching every aspect of Departmental life.

Our training resulted in success in academic and professional progression for our PGRs: 71% went on to academic posts, 14% industry positions, 5% higher education professional positions, 3% further training, 1% retirement, and 5% unknown.

2.3.1 Support mechanisms

The Department provides support for PGR students in terms of annual allowances for conferences/research/professional development, full access to research facilities, use of the Department's participant pool, and access to our school and preschool databases for developmental projects. Two dedicated professional services staff advise on supervision, training, and viva arrangements. All PGR students are supported by a supervision team comprising at least two supervisors, and are also allocated a mentor (outside their supervisory team), providing support on broader academic, development, and well-being issues.

All students have personal office space, and are actively encouraged to attend social and research events and to input into all the Department's committees. Our PGR community is active, organising an annual research conference, with talks, posters, and invited keynotes. Our PGR students are active members of the PROSPR open science group, and coordinate a fortnightly Departmental open science reading group (ReproducibiliTea), maintaining regular lively research discussions among staff and students.

2.3.2 Training in impact

The training programmes and networking opportunities organised by our £1.05M Leverhulme DSP and the NWSSDTP, the largest ESRC doctoral training partnership in England, are open to all our PGR students, and additional Department and Research Centre sessions dedicated to engagement, science communication, and stakeholder networking are made available to all our PGR students.

2.3.3 Continuing professional development

Training and development needs of PGR students are formally appraised every 6 months. During their studies, 53 (65%) PGR students have so far passed a Higher Education Academy accredited teaching qualification, as well as availing of ECRs training events, faculty and cross-faculty training provision (e.g., from training in long discursive argumentation in Faculty of Arts and Social Sciences, to mentor training in Faculty of Science and Technology). We also provide bespoke training events for students and staff, including training in open science approaches, advanced statistical analysis, and new methods (e.g., ERP, fNIRS) (see Section 4).

2.4 Equality and diversity

Equality, diversity and inclusion (EDI) are the cornerstone of our Department's open culture, with mechanisms built into all Department committees and strategies, corresponding with the

University's EDI plan. The University is a Disability Confident Committed employer (level 1) and a member of the Stonewall Global Diversity Champions programme, and the University will sign up to the Race Equality Charter in April 2021. The Department holds the Athena SWAN bronze award.

We have an EDI committee which oversees our Department EDI strategies and supports our Athena SWAN applications and appraisals. This committee regularly reviews career development policies, promotion case development, appointment strategy, and Department committees' membership to ensure equality of opportunity and recognition of diversity. All staff attend EDI awareness training within three months of appointment, which is mandatorily refreshed every 3 years; 97% of staff agree they are satisfied with level of awareness of diversity issues (88% in 2014).

All recruitment panels are gender balanced and all members of recruitment panels attend EDI training. We support job shares and flexible working and state this in our job adverts. In terms of T&R appointments by gender, during the REF period, 62% of applicants identified as female (from 60% of interviewees). Of our PGR students, 76% identified as female (appointed from 70% female applicants), 22% identified with BAME ethnicity, and 13% reported having a disability. 30% of our PGRs reported being first generation university attendees.

We encourage flexible working practices for all staff and research students to promote well-being. 24% of our T&R staff have opted for <100% contracts at the REF census date (33% of these were female). Departmental committees are scheduled between 10am-4pm to ensure staff with caring responsibilities are included, and we initiated a policy that Department business emails are sent between 7am and 7pm on working days (now adopted across several Faculties at Lancaster). For weekend work (e.g., campus visit days), caring responsibilities of staff are resourced, and for our most recently hosted international conference (Embodied and Situated Language Processing) the University funded childcare for delegates.

We ensure that staff are supported prior to, during, and following family-related leave. 10 T&R staff and 4 PGR students have taken family-related leave during the REF period. Prior to family-related leave, a management plan for research programmes is conducted with the line manager. During and after family-related leave, the University funds continuity of research by covering teaching and administrative duties. Staff are encouraged to use "keeping-in-touch" days to ensure smooth continuation of research and impact activities. Following family-related leave, administrative and teaching loads are reduced by 10-20%. **These policies have resulted in 100% of family-related leave T&R staff returning to work**, and **100% successful promotion cases** for these staff.

During the REF period we have improved our gender balance (see Figure 3). Our increasing seniority of staffing was largely achieved through targeted career development for female colleagues, from a staff comprising 39% female, 57% of Psychology staff attending University training courses during the REF period were female, 46% of promotion cases were from female staff, and all promotion cases for staff returning following family-related leave were successful (3 female and 1 male).

Further commitment to EDI is demonstrated by our use of a neutral algorithm for our final output selection. However, we recognise that continued progress is needed to address EDI with respect to training and promotions. To this end, we are remodelling our EDI committee to provide accountable stewardship for all protected characteristics of individuals.

3. Income, infrastructure and facilities

3.1 Income

Our grant income has increased by 176% compared to the previous REF period (£12.7M compared to £4.6M). Despite our focus on psychological research, rather than neuroscience and psychiatry which typically attract larger grant funding sources, our income per FTE (£58K/year

by 2019, up from £31K in 2013) places us in the top 14% of UoA4 by 2019 (compared to top 25% in 2013, HESA data).

Our strategy during the REF period for increasing research income has been to:

3.1.1 Utilise QR funding to support internationally leading research in large-scale projects
Over £5M of QR funding was assigned to our unit. We used this to improve research facilities, pump-prime the foundations of larger-scale projects particularly for ECRs, fund multiple PhD studentships, and to assign institutional contributions to large-scale funding programmes, to increase our capacity for large-scale integrated research and training programmes. These investments included £0.8M commitment to the Leverhulme DSP to fund an additional 5 PhD studentships and support lab management, and over £2.4M contribution to fund researchers, PhD studentships and administrative support for the three ESRC Research Centres. Consequently, we have been successful in securing initial and continued funding for these ESRC Centres.
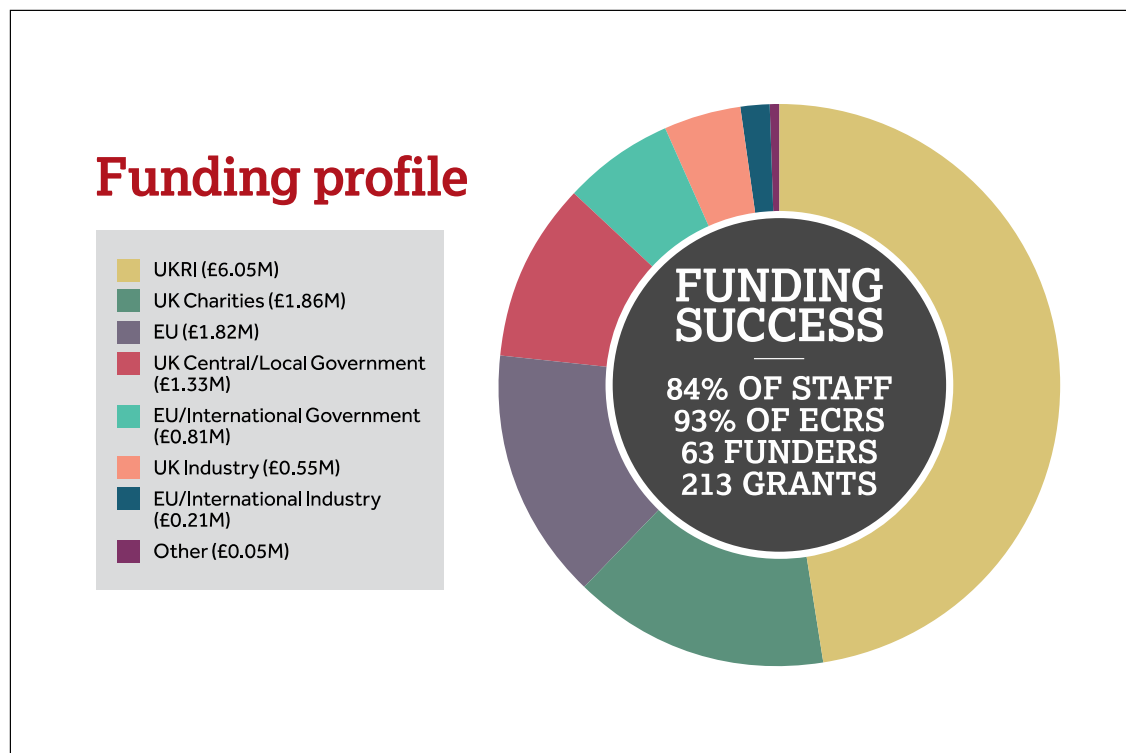

Funding profile

- UKRI (£6.05M)
- UK Charities (£1.86M)
- EU (£1.82M)
- UK Central/Local Government (£1.33M)
- EU/International Government (£0.81M)
- UK Industry (£0.55M)
- EU/International Industry (£0.21M)
- Other (£0.05M)

FUNDING SUCCESS
84% OF STAFF
93% OF ECRS
63 FUNDERS
213 GRANTS

Figure 4. Research funding by type of funder.

3.1.2 Diversify our portfolio of funding sources, to provide greater opportunity and stability for funding income
We work actively with our non-academic partners to co-develop research with impact, supported by pump-priming funds, impact acceleration awards, and HEIF funding. We have numerous collaborative programmes of work with 3rd sector, industry, and government. Consequently, we have received funding for 213 projects from 63 different external sources, including UKRI, industry, charities, and local and national government agencies (see Figure 4).

3.1.3 Support all T&R staff to develop active, funded research programmes
Our research groups encourage and support small-scale funding to demonstrate project leadership skills prior to developing large-scale applications. Of our ECRs, all have applied for funding with 93% success, including several UKRI grants and prestigious fellowships (e.g., **Dunn**'s Leverhulme Early Career Research Fellowship, **Hartley**'s ESRC Future Research Leaders Fellowship, and **Nuttall**'s BBSRC research grant).

3.2 Infrastructure and facilities

3.2.1 Overview of research facilities

We conduct research in two co-located facilities. The Whewell Building is a two-storey building entirely dedicated to psychological research (Figure 5). The 365m^2 ground floor houses a world-leading infancy and child research facility. An additional 390m^2 has been added in the REF period to house expansion of laboratory facilities for adult testing, including facilities for elderly participants. We also have sixteen dedicated labs co-located with staff offices across two storeys of the adjacent Fylde College building (total 324m^2) and a further 32m^2 suite of auditory booths in an additional building.

Figure 5. The Whewell Building for psychological research.

The infancy and early child development facility contains a suite of labs housing multiple Tobii eye trackers (2 stationary, several mobile), two additional head-mounted eye trackers dedicated to child/caregiver interactions (Positive Science units), four 128-channel EEG systems (EGI), an observation room with cameras, a Biopac MP150 system for motion capture, an 8-source 12-detector functional near-infrared spectroscopy (fNIRS) system (see Figure 6). There is a large welcome area for parents and their children, kitchen facilities, as well as offices for researchers and the lab administrator. To facilitate research and impact of the infancy and early development research, a dedicated lab administrator commenced in 2015 funded by the University to support our Leverhulme DSP. This post is continuing until 2024 as part of a £1.5M investment at Lancaster for the second phase of the LuCiD Centre.

Adult testing laboratories are equipped with a wide variety of cutting-edge techniques. We have 19 independent eye-tracking systems (with a range of portability, and spatial and temporal resolutions), 12 EEG systems (varying over portability, and numbers of channels to meet needs in the Department and for fieldwork), an extensive virtual reality suite and motion capture systems, 4 psychophysiological data acquisition units, polysomnography, recording suites, five double-walled sound booths, social interaction labs for groups and individual observational labs for adults, and both magnetic and multi-channel electric brain stimulation units. The Department also hosts a dedicated computational developmental neuroscience laboratory containing 32 integrated CPUs, and has access to the University's High End Computing facility comprising 10,000 CPUs and 49TB memory. Resources also include a psychometric and educational test library containing 250 tests. For MRI facilities, we access the scanner at Lancaster Royal Infirmary as well as through our collaborations with imaging labs internationally.

Figure 6. Facilities in our infancy and child laboratories (SMART eyetracking, EEG, fNIRS, 4D ultrasound, and head-mounted eyetracking).

3.2.2 Investment in facilities and infrastructure (since 2014)
We have invested £1.1M in new equipment and infrastructure, including over £240K dedicated to facilities supporting new appointments.

For our infancy and child testing laboratories, new investments focused on expanding our range of neurophysiological and behavioural testing methods. We have added: two EGI 128-channel EEG systems with integrated CCTV system and separate, dedicated data analysis computer facilities; our fNIRS system; the OptiTrack 5-camera body-motion tracker for infant perception studies; and the Biopac multi-channel biophysical system.

For our adult-testing laboratories, we have made parallel new investments in expanding our range of neurophysiological and behavioural methods:

- An *Aberrant Experience Lab* (established 2016) contains state-of-the-art transcranial electric brain stimulator (8-channel Neuroelectrics StarStim), and a fully-integrated biophysiology facility combining skin conductance, facial EMG, heart-rate (Biopac), FaceReader expression recognition technology (Tracksys), and thermal imaging (Flir technologies). This lab also has a new MkIII Intuitive Colorimeter for assessment and treatment of visual stress associated with migraine, epilepsy, and other neurological conditions.
- A *Neuroscience of Speech and Action Lab* (established 2018) houses state-of-the art transcranial magnetic stimulation (TMS: Rogue Resolutions), with integrated electromyography, TMS-compatible 32-channel electroencephalography (BioSemi), and a medical grade audio calibrator.
- *Auditory processing* facilities comprise five Industrial Acoustics Company double-walled sound booths (two added in 2017). These spaces are optimised for integrated auditory behavioural and neurophysiological testing containing a Biosemi Active 2 (32-channel) EEG and an International Hearing Systems Universal Smart Box. The facilities test basic audiometry, psychoacoustic discrimination, auditory electrophysiology, and speech-in-noise paradigms.
- Our *Virtual-reality Suite* has been expanded to contain 2x Oculus CV1 Head mounted Displays (HMDs), 2xOculus DK2 HMDs, 12 separate Optitrack Flex 13 Infrared Emitting Cameras, 1 Perception Neuron Motion Capture Suit, 3 X 5DT Motion Capture Data Gloves, and an Xsens motion capture suit. Ceiling-installed tracking cameras permit multiple users to move and interact with large virtual environments.
- Our *Sleep Lab* (established 2016) contains an Embla N7000 32-channel EEG / polysomnography system, and bespoke computer facilities for stimulus delivery and sleep scoring.

- We have developed methods of automated measurement of real-time nonverbal behaviour and mimicry using state-of-the-art motion tracking technology, including self-produced Bluetooth accelerometers as well as Liberty Latus, XSens MVN, and Notch sensor equipment. Our suite of analytics (Automated Measurement and Analysis of Body Motion, AMAB) is used by researchers at Cambridge, Utrecht, and Twente.
- A new *Video Analysis Lab* dedicated to the secure analysis of sensitive large-scale multimedia, multisource corpora (including CCTV, smartphone, body cameras, dashcams). The lab has three high spec workstations to enable simultaneous coders to work securely, and a secure data storage facility (encrypted hard drive plus lockable cabinet).
- Our wearable systems technology facilities include new systems linking EEG to smartphones, sociometric devices (measuring individuals' proximity), a BioPlux biophysical DAQ device for measuring emotional signals related to social interactions, and novel apps enabling link-up to commercial smartphone data collection systems (MetricWire) and the eDRIS system in Scotland for medicine-related projects.
- Naturalistic testing of perception, attention, and behaviour in fieldwork has been supported by new eyetracking facilities: 2 portable Tobii eye-tracking glasses, 3 portable Tobii eye-trackers (1 120Hz Tobii X3-120, and 2 60Hz Tobii Pro Nano system), an Eyelink mobile eye-tracker, and an SMS-Red eye-tracker system (120Hz) to complement our existing SR Eyelink 2000Hz system.

3.2.3 Research support
Our research facilities are supported by five staff: two research facility staff, a lab manager for the infancy and child facilities, and two computing/equipment technicians (one winning the BPS Technical Support Award, 2018). Our technical support staff cover software programming (Matlab / E-Prime / Python), electronic engineering (i.e., bespoke circuit boards / hardware for research), and support for configuration and operation of eye-tracking, virtual reality, EEG, and fNIRS. The technicians are encouraged to train in new techniques, and attend regular external and internal courses to ensure their skill sets are tuned to the Department's research support needs. Two of our research support staff have PhDs, enabling resources and technical needs to be effectively aligned with research outcomes.

3.2.4 Impact support
Impact is supported by a senior academic impact champion within our Department, and a full-time Faculty impact manager. Together these roles work with staff to identify: potential avenues of impact, relevant stakeholders, and impact-related funding (e.g., impact acceleration awards). Through support from these roles, we have secured within the REF period 13 impact acceleration awards from ESRC, EPSRC, MRC, and HEIF, cementing partnerships with 12 stakeholders, including government bodies (e.g., Scottish Government, Public Health England, UK Intelligence Agencies), charities (e.g., British Heart Foundation), and industry (including software and digital health companies). The Department impact champion reports to the Faculty impact manager and to the Department's Research Committee. Additional support comes from our research centres, the University interdisciplinary research organisations, and business engagement partners, each of whom have established links with stakeholder groups.

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

4.1 Contributions to the research base and discipline
To promote growth in the capability and capacity of our research groups and their wider community, we have engaged in four strands of activity.

4.1.1 Forming academic partnerships
At a Department level, we have formalised strategic bilateral links with the Universities of Kyoto (Japan) for multi-lab studies of cognition and memory (3 joint publications since 2016, e.g., **Towse**'s collaboration with Saito on joint cognition), Sunway (Malaysia) for multicultural studies of child development (7 joint publications since 2016, e.g., **Bremner**'s collaboration with Woo on the other-race effect for child face recognition), and Twente (Netherlands) for a Europe-wide

perspective on security and forensic psychology (11 joint publications since 2014, e.g., **Conchie** and **Taylor**'s collaboration with Larner on cross-cultural influences on deception in interviews).

We prioritise research that enriches the quality and quantity of research in the developing world (such as our links with researchers in south-east Asia, and across 10 African countries, e.g., **Alcock**'s 3 joint publications with Abubakar from Kenya Medical Research Institute, and Sebayang from Summit Institute of Development, Indonesia, on nutrition and children's cross-linguistic development). This enables us to respond to UKRI initiatives in terms of accessing developmental fund support for priorities in developing economies, e.g., **Cain**'s (2019-2023) British Academy/Global Challenges Research Fund project developing multi-lingual open-source story-based materials for preschool children (with Sussex and Stellenbosch Universities, and Wordworks, a South African non-profit organisation).

These collaborations are further extended by invitations to speak at 106 conferences/workshops (74 international, more than double our activity in REF2014), invites to give 55 seminars across 18 different countries, ERASMUS exchange visits across 8 countries, receipt of 10 international visiting Professorships/Fellowships, 35 academic visitors (>1 week) from 14 different countries, coordination and involvement in 3 EU ITNs (**Reid**, 2014-2017, 2019-present; **Cain** 2019-present), and invites to examine research degrees at 58 universities (26 international). Consequently, we have 339 international co-authorships on our publications from 47 countries across 6 continents (Figure 7): an established global network.
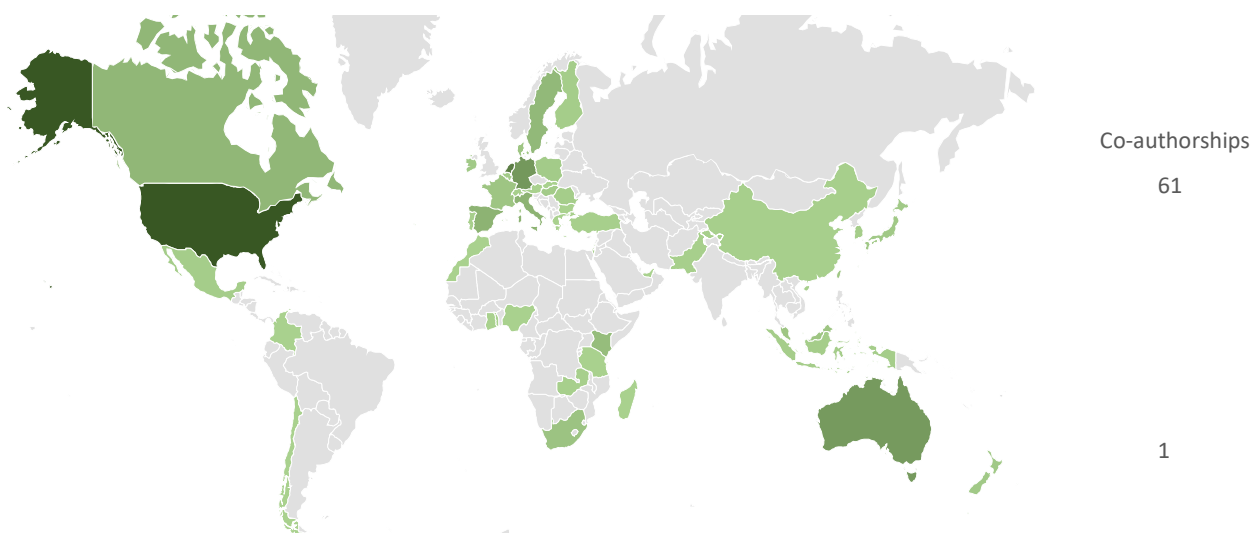

Figure 7. Number of co-authorships of publications in each country.

4.1.2 Hosting academic conferences
We have organised 38 conferences and workshops attended by 3260 delegates, and 13 academic or professional training events attended by 625 participants, double the number of the previous REF period. These included 7 International conferences in *Infant and Child Development* (~100 delegates annually), *Language and Communicative Development* (~90 delegates); *Behavioural and Social Science in Security* (~125 delegates), *International Military Design* (~70 delegates), *Embodied and Situated Language Processing* (~100 delegates), *Architectures and Mechanisms for Language Processing* (~300 delegates), *Society for Text and Discourse* (~400 delegates), and the *Implicit Learning symposium* (~150 delegates). We host weekly departmental seminars involving high-profile and early career researchers (75 speakers, 20% international), and support seminars organised with University cross-faculty centres and institutes and the ESRC Centres.

4.1.3 Leading open science
We have been at the forefront of the open science movement in the UK and internationally, embracing the principles of open and reproducible research, and embedding them within our

research practices. We contributed authorship to 3 of the 5 UKRN reports on open science approaches. We have shifted our research culture during the current REF period: in a 2020 Department survey, 81% report pre-registering studies, 75% make study materials publicly accessible, 67% make data publicly available, and 95% seek to engage further with open science practices (compared to social science norms of 7% of articles providing access to data, and 0% pre-registered studies between 2014-2017, Hardwicke et al. 2020, *Royal Society Open Science*). We have increased discipline-specific training opportunities, through Departmental events (e.g., our R for Psychologists workshops, our weekly "New Tricks" methods training events) and external funders (e.g., ESRC-funded "Future Proofing your Research: Moving Towards Open & Reproducible Research"; Leverhulme Trust funded "Advanced Bayesian Analysis"), and led University-wide initiatives such as Open Research Cafés and Data Conversations (hosted by the University library). We have now embedded open science ethics and practices in all our methods teaching at undergraduate and postgraduate levels.

In 2014, **Lynott** and **Connell** published one of the first registered report journal articles and we have introduced registered reports at journals where they serve as editors/associate editors. For example, **Towse** (founding editor, *Journal of Numerical Cognition*), adapted open-source journal management systems to align with open-science workflows supporting their implementation within publisher portfolios.

During the REF period, we have contributed to numerous international, large-scale open science collaborations, e.g., Many Babies Consortium (**Alcock**, **Westermann**), several different large-scale replication projects (**Connell**, **Lynott**, **McLatchie**, **Parise**, **Warmelink**, **Westermann**), and projects under the *Psychological Science Accelerator* combining resources from hundreds of labs around the world (**Lynott**, **McLatchie**). **Lynott**'s DARPA-funded SCORE project used machine learning techniques to understanding replicability of studies across the sciences, and **Groen**'s Collaborative Replications and Education Project embedded open science practices in educational practice.

4.1.4 Providing science leadership
Our practices have enabled us to take leading roles that shape the discipline. We have provided 4 editorships: *Infancy* (**Bremner**), *Legal and Criminological Psychology* (**Taylor**), *Scientific Studies of Reading* (**Cain**), and the founding editorship of *Journal of Numerical Cognition* (**Towse**); 9 associate editorships, including *Child Development* (**Bremner**), *Cognitive Science* (**Monaghan**), *PLoSone* (**Boyd**, **Reid**), *Trends in Hearing* (**Plack**); 11 special issue editorships; and 32 editorial board memberships. We have also held membership positions on 5 grant committee panels, held 40 reviewer positions for international grant awarding bodies across 13 countries, and routinely reviewed for 7 national grant bodies.

We have provided leadership in key learned societies, including 25 committee memberships for a variety of professional bodies, e.g., **Cain** is President-Elect of the Society for the Scientific Studies of Reading (2020) and **Towse** was Honorary Secretary (2015-2018) of the Experimental Psychology Society. Our leadership has been recognised through academic awards: Samuel Torrey Orton Award, International Dyslexia Association (**Cain** 2014); Wiley Research in Literacy Education Award (**Groen** 2019); Cognitive Science Society Computational Modeling prize (**Monaghan** 2016); and Mid-Career Achievement Award, European Association of Psychology and Law (**Taylor** 2017).

4.2 Research with economic and societal impact
The University interdisciplinary centres, institutes and ESRC Centres provide established mechanisms for large-scale contributions to research and impact.

4.2.1 Education and health communication
The £9.5M ESRC centre LuCiD provides a forum for interdisciplinary research in child communicative development. It hosts an annual conference on Language and Communicative Development, regular seminars, skill training workshops, and outreach events. It has an impact advisory panel comprising leading representatives from education and health practice (e.g.,

Better Start Blackpool, NHS Foundations Managers, Royal College of Speech and Language Therapists), and charity and government advisory policy makers (e.g., Education Endowment Foundation, ICAN, National Literacy Trust). This panel meets annually, and disseminates executive summaries of LuCiD research through their organisations' newsletters and websites. Networking with non-academic partners is facilitated via a Centre Manager, Centre administrator, and an impact and engagement post hosted at Lancaster University (2020 onwards). We are also members of the N8 (8 research-intensive North England Universities https://www.n8research.org.uk) developing the "Child of the North" research priority.

We have advised practitioners from the NHS and local educational authorities at four opportunity areas selected by the Government's Social Mobility Commission on designing and delivering interventions in preschool children's language development (**Monaghan**, through LuCiD in collaboration with The Communication Trust). **Cain's** work with the Department for Education informed changes to reading instruction in all local authority maintained schools in England (ICS), and **Cain**'s membership on the AIM Academy Research Board informed interventions for children with special educational needs (300 children), and her membership of the PISA 2018 expert group informed the OECD Programme for International Student Assessments.

We have invested in developing our research in education and wellbeing in conjunction with the Eden Project North, a £110M investment under development to be located 8km from Lancaster University. We have appointed **Hurlstone** who has a track-record of environmental psychology to provide a direct link to the Project.

4.2.2 Neuropharmacology and health

We work with University-wide initiatives to deliver regional and national impact for our health-related research in the *Perception and Action* and *Language and Cognition* research groups. The Health Innovation Campus (HIC) has a dedicated team of partnership development staff for linking researchers, SMEs, and NHS groups, with a collaborative space for meetings and conferences. Relatedly, the Centre for Ageing Research disseminates its research with practitioners and the general public with a widely-distributed annual report and "town hall" conference to showcase its research. **Davies**, through a 2019 ESRC impact acceleration award, has developed improved comprehension of medicine labels with the NHS with support of the HIC.

Sünram-Lea's advisory role on Nestle's R&D committee and Danone's scientific committee has shaped their R&D strategy in terms of product investment, and her work with GlaxoSmithKline led to the development of lower sugar versions of energy drinks (see ICS).

4.2.3 Security and trust

On the psychology of security, the £11.8M ESRC centre CREST has shaped the field by: (1) running an annual £1M commissioning call that engages new researchers and new disciplines on topics of national importance (e.g., cross-cultural research on information elicitation); (2) running a £150k a year network programme that engages UK researchers and security stakeholders in seminars and workshops with over 12 events a year focused on ECRs; (3) running a website that reaches over 100,000 unique users with blogs and professionally written short stories about research and its policy import; (4) producing 695 outputs in the form of briefs, guides toolkits, and talking head videos; (5) producing a quarterly magazine CREST Security Review (CSR) that presents in accessible form psychology for security. CSR has a readership of over 3000, including governmental Chief Scientific Advisors across the globe; (6) employing three Research-to-Practice Fellows whose role is to help researchers understand how best to engage with stakeholders. These Fellows also take on major impact projects, such as the delivery of a national training framework based on evidence produced by the Centre.

Through CREST, **Conchie**'s work with policing informed the development of an evidence-based guidance, which is in use nationally to guide decision-making, and **Taylor**'s research on elicitation is incorporated into best practice in Canadian, EU, UK, and US policing, including the US High-Value Detainee Interrogation Group. CREST delivered a rapid response to the COVID19 pandemic by providing evidence-based advice on remote interviewing and managing

escalation in relation to the Black Lives Matters campaign, and accelerating online CPD training provision and delivery of evidence briefings.

In tandem, the £1.4M EPSRC funded network SPRITE+ provides interactivity and cohesion among the research community, develops and curates links with stakeholders, and works to identify key national and international priorities for interdisciplinary research with a primary focus on digital security and privacy. SPRITE+ has project partners from communications and defence industries (ARM Ltd, BT, Nasdaq, National Grid, PLEXAL, Tiani Spirit, and Titan IC systems) and the UK Government Office for Science. These partners collaborate with researchers to define priorities for research programme objectives. **Levine**'s multi-source data research, in conjunction with the University's Data Science Institute, has informed the DSTL's evacuation modelling and emergency response training.

Security Lancaster (**Taylor**) secured £1.4M to build a secure data science infrastructure that allows our staff to work on sensitive data on campus; secured the £6M Greater Manchester Cyber Foundry and £1.5M SecureD University Enterprise Zone (with the Data Science Institute) that facilitate joint work with industry; established a strategic relationship with the industry accelerator PLEXAL to link social processes research to the financial sector; developed strategic relationships with Fujitsu and Raytheon who fund PhD and project work on issues relating to cyber security leadership and safety behaviour; and developed ties with the N8 Universities in security research.

Our research with impact has been recognised through several awards from professional bodies: an honorary consultancy in Pediatrics from the NHS (**Reid**, 2016), a senior ambassadorship for Providing Opportunities for Women in Educational Research (**Cain**, 2019), and 8 national government committee memberships or consultancies (including **Alcock**: Department for Education expert advisor; **Taylor**: UNESCO's International Consensus Guidelines Committee for the Prevention of Violent Radicalization and Extremist Violence, and Ministry of Defence research ethics panel).

4.3 Public engagement
In 2015, **Hartley** founded the Psychology Employability Programme providing psychology students with vocational work experience alongside their academic studies. We have placed 89 students with a wide range of organisations including local community groups, national charities (e.g., National Autistic Society), and international social enterprises (e.g., SLV Global which supports mental health). These placements enable us to work directly with these organisations to explore joint interests and generate pilot work for larger-scale collaborative projects.

We organise regular events with community groups. For example, we have delivered 3 "Insight into Autism" events for parents, carers, and educational practitioners (50 delegates per year) and contributed biannually to the ESRC Festival of Social Science. We participate in hands-on events such as the University's "Science Hunters" and "Campus in the City" annual public events, showcasing our infancy and early development research (>600 annual attendees), and University Science public outreach talks. During the first COVID lockdown, we arranged a series of 7 online publicly accessible talks on psychology (>1500 attendees).

The University Press office supports our dissemination of news briefings and news stories, with a press officer specialised in communicating work in Psychology. During the REF period, our research has reached combined audiences of >39.7M for television and >25.3M for radio appearances. In the print media, we have had 1.7M readers of our 40 articles in *The Conversation*. Key examples of broad coverage are **Reid** and **Dunn**'s (2017) *Current Biology* paper which reached an audience of >1 billion, and was subsequently included in *Discovery Magazine* as one of the "top 100 scientific discoveries" of the year; **Boyd**'s (2020) *Science Advances* paper (audience >211M), and **Levine**'s (2019) *American Psychologist* paper (>192M).

Oriented around our four research groups, we provide stimulation for staff to grow new collaborations, connect with stakeholders in the public and private sectors, and deliver their

knowledge in innovative ways. This sustains the flow of research to impact that has led Lancaster to shape national and international policies and practices in security, education, and health settings.