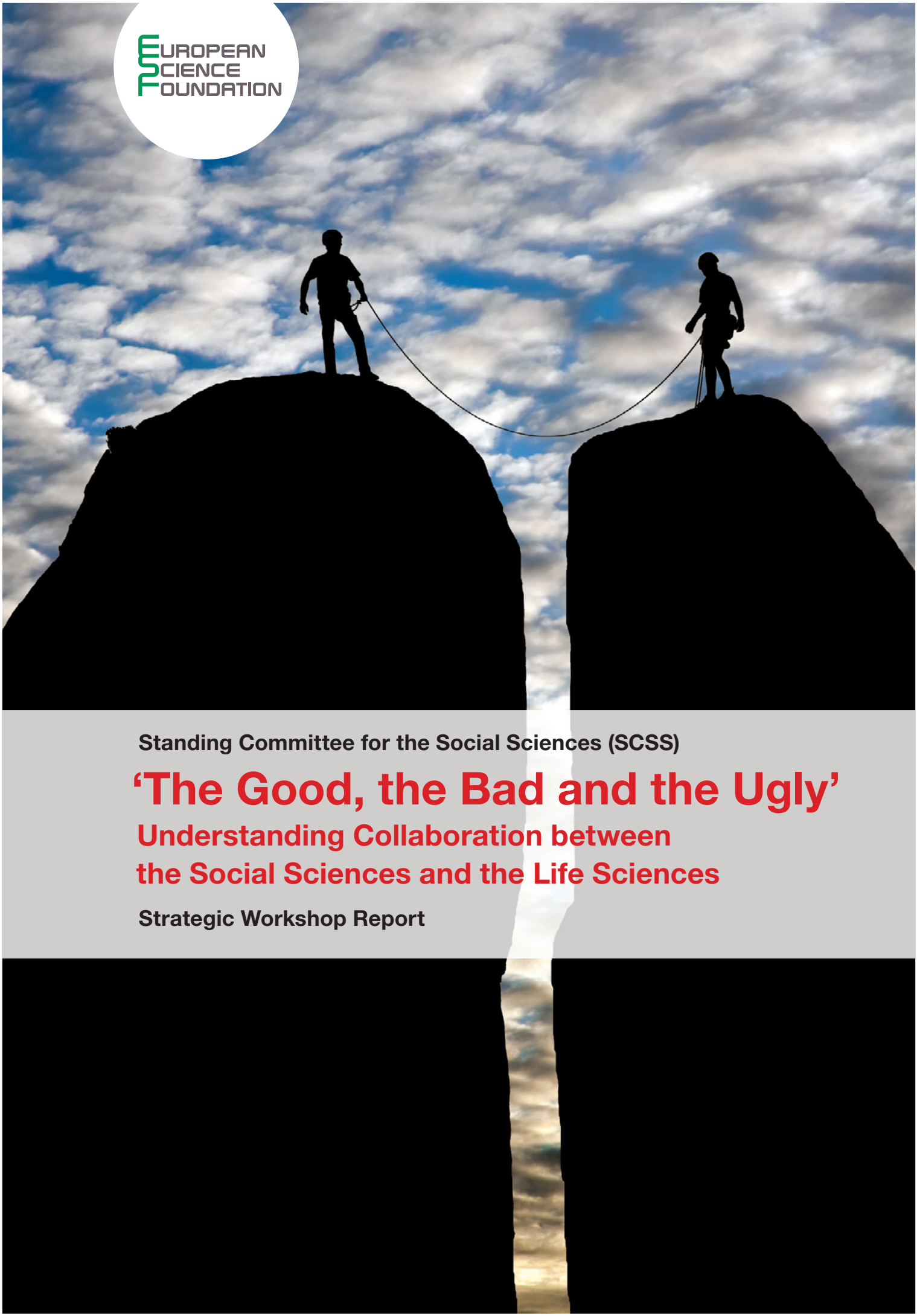

Standing Committee for the Social Sciences (SCSS)

‘The Good, the Bad and the Ugly’

Understanding Collaboration between the Social Sciences and the Life Sciences

Strategic Workshop Report

European Science Foundation (ESF)

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This report is the outcome of a Strategic Workshop of the Standing Committee for the Social Sciences of the European Science Foundation, which was hosted by the Department of Social Science, Health and Medicine, King's College London, in March 2012.

Author

Dr Des Fitzgerald, Department of Culture and Society – Centre for Interacting Minds (IMC), Aarhus University, Denmark

Case-study authors

Dr Eric Brunner, Department of Epidemiology and Public Health, University College London, United Kingdom

Dr Philipp Koellinger, Department of Applied Economics, Erasmus University Rotterdam, The Netherlands

Dr Arcadi Navarro, Institute of Evolutionary Biology, Universitat Pompeu Fabra, Spain

ISBN: 978-2-918428-91-6
Cover picture: © iStockphoto

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Foreword

Perspectives on the Relationship between the Social Sciences and the Life Sciences

Interdisciplinarity is in demand. Less clear, however, are the why, the what and the how – why one should seek interdisciplinarity, what it is, how it should be achieved in practice. Is it an epistemological requirement – because the objects we seek to understand do not conform to the boundaries of the disciplines as they were established in the nineteenth century and formalised in textbooks and educational practices in the twentieth? Is it an organisational requirement, because we need to shake up the ossified structures of the universities and their departmental enclaves and rivalries? Or is it a pragmatic requirement – because the nature of the problems we seek to understand requires the collaboration of experts from a wide range of backgrounds?

These issues are especially pertinent in the relations between the life sciences and the social sciences – which were the focus of the ESF workshop in March 2012 which is described in the following report. Transactions between these two domains of knowledge were intense across the nineteenth century – with the social sciences borrowing many metaphors and models from the life sciences, and the life sciences often imagining their concerns in metaphors taken from the social life of their times, and indeed often suggesting that key features of human life were shaped by their biology. But during the twentieth century, such transactions were gradually displaced by hostility and mutual suspicion, notably as twentieth-century biology and genetics became associated with reductionism and determinism, and social science seemed to aspire to an equal and opposite 'purification' from biology. As our own century develops, the possibilities for interaction seem more positive. Many life scientists – in genomics, in neuroscience, and in biomedicine – recognise that the old distinctions between organism and milieu are no longer viable, that, to use a phrase now becoming a cliché, the environment is not just 'out there' – the concern of a different form of knowledge – but 'gets under the skin'. And, from the side of the social sciences, we see a renewed interest in, and recognition of, the fact that human beings are indeed animals, very special animals, whose social existence and survival – in the age of the 'anthropocene' – is intrinsically linked to their characteristics as a living species, in one ecological niche among others in a complex planetary ecosystem. No doubt there is much to be said here about the wider forces that have generated these developments, ranging from the politics of higher education to the rise of new social movements.

But the demand for interdisciplinarity between the life sciences and the social sciences also comes from another source – the current popularity of 'grand challenges' as they are articulated by so many national and international funding bodies, as in the Grand Challenges for Global Health, for Climate Change, for Poverty Reduction, for Human Wellbeing and the like. Each of these challenges seems to require researchers in the life sciences, the social sciences and indeed the human sciences to break out of their disciplinary silos. As, of course, do so many other fundamental issues that confront us – poverty, for example, is neither simply social nor simply biological – it is a socio-political, ecological and experiential phenomenon that is written in the body as well as in a form of life. But if interdisciplinary relationships now seem obligatory to address such challenges, not least because it is

increasingly required if researchers are to achieve funding, how should they be conducted? Are they to be interactions within a 'trading zone', to use Peter Galison's term – where each discipline does what it knows best, and somehow their combined efforts are assembled? Should one aim for something more, perhaps a kind of interliteracy, where the practitioners of each discipline try at least to learn the language and understand the approaches of the others? Or is it possible, or desirable, for the integration to be more profound, such that the distinctions between the training, language, forms of experiment, evidence, proof, styles of thought of the different practitioners begin to blur? What would be the implications – perhaps the creation, over time, of new disciplines, each with its own textbooks, structures of authority, and modes of normal science?

Whatever the future might be, in the present one should not minimise the asymmetries of power, authority and funding levels that traverse all attempts at interdisciplinary collaboration. These are particularly acute in relations between the well-funded and high status life sciences and biomedicine and their less fortunate cousins in the Geisteswissenschaften. Scientific research today is, however, a thing of this world, and jobs, careers, promotion, funding and social status are all at stake in the ways in which research is framed and pursued. If interdisciplinary research is necessary, as it surely is, to meet the profound challenges that face the human species today, those who have the power to make it possible need to recognise that it remains risky. It is difficult to organise, inescapably time consuming especially in its early phases, a hazardous endeavour especially for those at an early stage in their career, often frustrating and dispiriting for those who seek to pursue it, and even less certain of success than more traditional forms of research. But if those difficulties can be lived with and overcome, the intellectual, practical and personal rewards can be very great. The discussions at the ESF workshop which are recorded in what follows testify both to the difficulties and to the rewards if these collaborations are pursued with integrity and commitment. They highlight the need for some very pragmatic forms of institutional support if such experiments in interdisciplinarity are to flourish. But they also suggest that, if those infrastructural conditions are provided, we can begin to challenge that divide between 'the social' and 'the biological' that has proved so damaging for those who seek to create a genuinely human science.

Nikolas Rose, *King's College London*

Executive Summary

Recent decades have witnessed revolutionary advances in the life sciences that have given rise to fascinating but difficult new questions about the complex nature of the relationships between brain, genes and human and social behaviour. Collaborative research between the life sciences and the social sciences is now indispensable for the investigation of some of the most challenging and urgent scientific and social questions that face us in the twenty-first century.

In March 2012, on the initiative of ESF's Standing Committee for the Social Sciences, a strategic workshop was held to study the factors that contribute to or impede good and successful collaboration between life scientists and social scientists – and pitfalls that turn good intentions into 'bad' or 'ugly' collaborations – and to understand why interdisciplinary collaboration between social scientists and life scientists – especially, high-quality or 'good' collaboration – is so rare.

Based on empirical analysis of six case studies, the definition of 'good' interdisciplinarity agreed on at the workshop prescribed truly *inter*-dependent collaboration (whether the contributions are conceptual, technical or methodological), based on broadly equal or symmetrical relations between researchers from life science and social science disciplines respectively. Bad or ugly collaboration, on the contrary, may involve 'hit and run' tactics, imbalanced contributions or relations in the partnership, and lack of real mutual engagement or understanding of each other's epistemological standards and assumptions.

To a certain extent the issues discussed at the workshop applied to interdisciplinary collaboration in general; however, they also homed in on features specific to collaboration between disciplines in the domains broadly known as life science and social science.

The report's main findings are that:

1. There are clearly different motivations, modes, practices and conditions of good collaboration, but all of them share some specific, replicable elements, such as: tolerance of epistemic ambiguity; the presence of trust and willingness to take risks; a nuanced awareness of context within the domain of the 'other'; managing (the relationship between) physical and epistemic distance; the timely availability of resources.
2. There are identifiable barriers to good collaboration, including: the risk to junior careers and other institutional barriers, such as research funding cultures and institutionalised disciplinary hierarchies; variability in methodological standards; the ability to assess others' expertise; the inaccessibility of data; and the disciplinary ecology of academic publishing.

The report concludes with a series of recommendations for researchers, administrators, funders and policy-makers:

1. *For researchers:* be willing to take risks; learn to balance the competing demands of justified trust and enchantment vis-à-vis the other's expertise.
2. *For research administrators:* cultivate 'discipline-transcendent' senior scholars, as well as a new generation of flexible, cross-disciplinary junior researchers, through opportunities for interdisciplinary research projects, positions and career paths; be attentive to and address the politics of power and prestige within the academy.
3. *For funders:* make provision for exploratory interdisciplinary research, for example, through fast and flexible seed-funding; create better

conditions for data mobility and accessibility; invite collaborative research proposals on cross-domain challenges framed by social scientific questions; make interdisciplinarity a measure of research impact.

4. *For policy-makers and higher education leaders:* create interdisciplinary research councils, review panels or other dedicated evaluation and funding mechanisms; re-think the narrow disciplinarity of PhD training.

1. Introduction
Birth of an Initiative

The late twentieth and early twenty-first centuries have witnessed revolutionary advances in the life sciences and their technologies, producing new data, new insights and new theories about human and social behaviour and giving rise to fascinating but difficult new questions about the complex nature of the relationships between brain, genes and human and social behaviour.

Analysing the challenges (both social and scientific) posed by these developments is not only a task for the social sciences. A new world of possibilities has opened up for the *interdisciplinary* exploration of human life and its social and physical context.

However, at the moment of writing, the meeting of life scientists and social scientists in joint endeavours to integrate and transcend disciplinary knowledge about human and social behaviour is still rare: social scientists seem to harbour suspicion about advances and findings in the life sciences, while life scientists also seem to hesitate before social scientific knowledge, and are slow to appreciate social scientific approaches, or to engage with them in a meaningful way.

Taking note of the considerable opportunities *and* obstacles presented by this new research horizon, the Standing Committee for the Social Sciences (SCSS) of the European Science Foundation (ESF) identified collaboration between social sciences and life sciences as a key cross-cutting challenge for the twenty-first century in its 2009 Position Paper *Vital Questions – The Contribution of European Social Science*. The SCSS consequently decided to launch a strategic initiative with a view to achieving a better understanding of this type of collaboration and making it more accessible and more effective. In the framework of this initiative, a strategic workshop was organised, with the involvement of the Standing Committee for the Humanities (SCH) and the European Medical Research Councils (EMRC), in which specific cases of inter- or transdisciplinary research between the social and life science domains would be examined, in order to identify and discuss practices, experiences, achievements and pitfalls of actual collaborative efforts. The differences between the epistemic cultures of life science and social science disciplines were to be explored, as was the question of how reliable knowledge is arrived at in such inter-domain collaborations. A point of discussion would be how issues relevant to social and life sciences could be better articulated and framed to help overcome suspicion and to promote mutual understanding and genuinely collective effort. The workshop would address what counted as good or bad practice in interdisciplinary collaboration between the social and life sciences and would aim to draw conclusions and offer recommendations about needs and priorities vis-à-vis interdisciplinary collaboration between social and life sciences.

A small Programme Committee was formed to steer the activity, representing various disciplines, interests and ESF activities: Adrian Alsop (SCSS, ESRC), Jeremy Freese (Northwestern University), Pasqualina Perrig-Chiello (SCSS, University of Bern), Robert Plomin (KCL) and Nikolas Rose (KCL, Chair of the ESF's Research Networking Programme 'European Neuroscience and Society Network'). The workshop that finally took shape, entitled *The Good, the Bad and the Ugly: Understanding Collaboration between the Life Sciences and the Social Sciences,* was convened at the recently established Department of Social Science, Health and Medicine at King's College London on 12–13 March 2012. The participants and the specific cases of interdisciplinary collaboration studied were

largely drawn from past and current ESF activities, with the additional participation of invited experts and practitioners. The following report provides an account of the theoretical discussions and empirical reflections at the workshop, as well as an analysis of the findings and some tentative conclusions and recommendations for research and for policy.

2.
Good, Bad and Ugly: Contemporary Collaboration between Social Scientists and Life Scientists

2.1 Assumptions and Ambitions of the Workshop

The workshop emerged from the following intuition: it has increasingly been recognised that (1) in order to think meaningfully about human social life in general, we also have to think with and about the roles of biological phenomena such as genetic inheritance and our neurological capacities; but also that (2) in order to think critically about the development and performance of our genetic and neurological abilities, we have to take into account the co-constitutive role of the social environment. Even so, and despite some notable exceptions, collaboration between social scientists and life scientists remains the exception rather than the rule.

Participants at the workshop agreed that interdisciplinary, collaborative research between life sciences and social sciences is becoming indispensable for the investigation of some of the most challenging and urgent scientific and social questions that face us in the twenty-first century. But they also recognised that there are considerable barriers to interdisciplinary research endeavours – barriers that are epistemic, institutional, bureaucratic, and even psychological in nature. Given the existence of these barriers, one of the foundational assumptions of the workshop was that the volume of high-quality interdisciplinary research collaboration between life scientists and social scientists most probably does not meet demand, and that this area of activity would benefit not only from the lowering of these barriers, but also from the provision of positive enabling measures.

The driving ambition of the workshop was to understand what, *in practice*, enabled 'good' collaboration between the life sciences and social sciences; it looked for the main and specific barriers that impeded these kinds of endeavours, as well as the pitfalls that threatened to turn good intentions into 'bad' or even 'ugly' collaborations (more on this below); and it strove, finally, to begin the conversation about what policy-makers, funders, research mangers, and even individual researchers, might concretely do in order to foster the good and discourage the not-so-good. Thus, the key questions and themes that ran throughout the workshop were:

i. **Modes of collaboration**: What does collaboration between the life sciences and social sciences actually look like? Are there different kinds? What distinguishes them from one another? Are different kinds of collaboration better suited to answering different kinds of questions?
ii. **Elements of successful collaboration**: Where good collaborations exist between the life sciences and the social sciences, what actually makes them possible? What are the major replicable elements of these successes? And what stops 'good' collaboration from becoming 'bad' or 'ugly'?
iii. **Barriers to good collaboration**: Where good collaboration has been impeded or even stymied, what were the barriers? What turns good collaboration to bad? And what prevents social scientists and life scientists from getting involved with one another in the first place?

With these themes and questions in mind, the workshop was structured around two elements:

i. Over-arching framing and conceptual contributions, to help participants get analytical purchase on the empirical material;
ii. A series of case studies, representing more-or-less successful collaborations between life scientists and social scientists, presented by a member of the team.

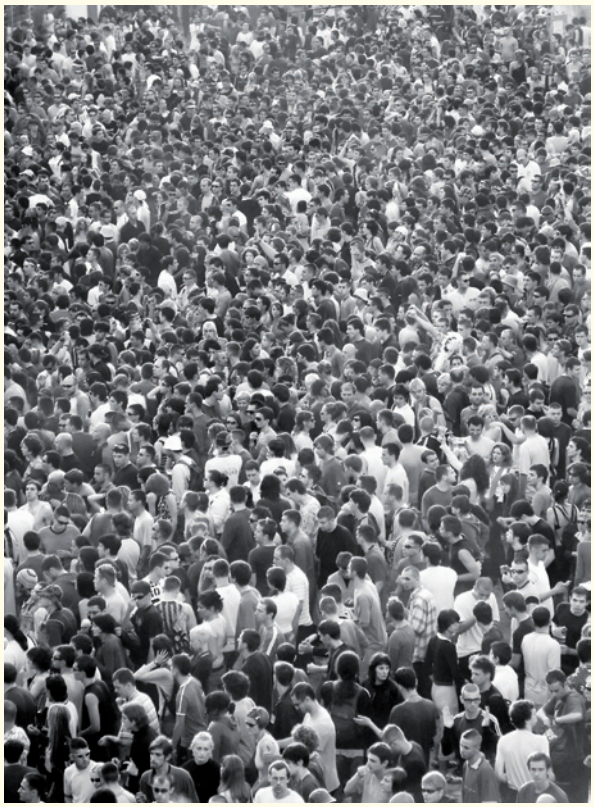
The workshop was thus itself set up as an empirical endeavour, in which case-study data, as well as theories about kinds of collaboration, would be used to draw some fairly robust and pragmatic conclusions. Those conclusions are described later in this workshop report.

A detailed description of a selection of the case studies is offered in Section 3 below. In brief, they were:

1. 'Oxytocin modulates human cognition and behaviour in conflict and cooperation' (Carsten De Dreu, University of Amsterdam);
2. 'Integrating epigenetic epidemiology into studies of mental illness' (Jonathan Mill, Kings College London);
3. 'The Social Science Genetic Association Consortium (SSGAC) – Pilot Project on Educational Attainment' (Philipp Koellinger, Erasmus University Rotterdam);
4. 'The Whitehall II study: a successful interdisciplinary paradigm?' (Eric Brunner, University College London);
5. 'Religious prayers in a neurocognitive framework' (Andreas Roepstorff, University of Aarhus);
6. 'The Social and Mental Dynamics of Cooperation' (Arcadi Navarro, Universitat Pompeu Fabra)[1].

2.2 Some Definitions

Many of the terms used in this document have little conceptual clarity, being widely and variously employed in different intellectual genres and contexts. 'Interdisciplinarity,' in particular, is a term much used but often ill-defined. However, when we refer in this document to 'interdisciplinary work' between the life sciences and the social sciences, or more simply to 'interdisciplinarity,' we mean to imply more-or-less inter-dependent collaborative endeavours (whether the contributions



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are conceptual or methodological), founded on broadly equal or symmetrical relations (in terms of epistemic contribution), between one or more disciplines – where at least one belongs to each of the two broadly-defined domains set out below. We also distinguish this notion of interdisciplinarity from attempts to combine different kinds of expertise or training in one person, and from the (usually) quite distinct interactions and aims in the social study of science and technology, even where this entails quite close cooperation between life scientists and social scientists.

The collaborations that we have in mind may come about because of a desire to answer a research question that does not obviously belong to only one domain; they may be part of a strategy to take advantage of datasets or methods that belong in the other domain; or they may more fundamentally arise from an idea that the objects of our social and natural environments simply cannot be exhausted by perspectives from one domain alone. In any event, these basic qualities of inter-dependence, cooperative labour, and mutuality, all oriented towards a shared intellectual purpose, is essentially what is intended by 'interdisciplinarity' and 'collaboration' here (cf. Rabinow and Bennett, 2009).

However, as was clear in the case of life sciences and social sciences, we may be more often talking about relations and gaps between much broader and more disparate *domains* of knowledge, than 'disciplines' as such. What this implies is that beneath the

1. The final case study was finally not presented in person at the workshop, due to unforeseen events.

loose talk of 'life sciences' and 'social sciences' lies a spectrum, both within and across each domain, of (sometimes recently institutionalised) disciplines, featuring qualitatively different ideas about standards, arrayed across a vast differential of prestige and power, and each with its own complex and distinctive set of epistemological and ideological commitments. Disciplines in any given domain may indeed have much more natural affinity with cognates in *another* domain than in their own. Nonetheless, the workshop exercise was premised on the assumption that there is a real and identifiable 'gap' between what may be broadly called 'the social sciences' and 'the life sciences' – a gap important enough to justify eliding some nuance and specificity in what follows. Thus when we talk about gaps between the 'life sciences' and 'the social sciences' the *kinds* of difference outlined in Table 1 are what are broadly intended (cf. Kagan 2009). Finally, as for the domains themselves, by 'social sciences' we include all those disciplines that take either the social environment, human social behaviour and relations, or the fact of human sociality in general, to be their basic object of intellectual concern. This includes – perhaps problematically – both: (1) the qualitative social sciences (such as anthropology or much of sociology), for whom 'the social' is often an ambiguous web of 'meaning', an object which nonetheless cannot be apprehended 'objectively', which may not be generalised, and which may be only (partially) brought into view through a heavily interpretive research practice; and (2) the quantitative social sciences (such as many parts of economics, or social epidemiology), which are perhaps more willing to understand society and social interaction as objects of research which may, in fact, be apprehended as things 'out there', which may be aggregated through some numerical measures, thus becoming more generalisable and also more distanced from individual researchers. By 'life sciences', on the other hand, we include all those disciplines that are interested in the characteristics, propagation and health of living organisms – for our purposes, principally, but not exclusively, humans – and perhaps being most particularly concerned with those emerging, technologically-based, and multidisciplinary domains of the life sciences in which human behaviour and sociality is increasingly an object of concern (for example, the new genetic and brain sciences). Table 1 attempts to sketch a more workable set of distinctions between these two schematic types.

2.3 Current Research on Interdisciplinarity

Without attempting to document exhaustively the state of the art in research on interdisciplinarity, we do wish to draw attention to some of the literature that especially informed the discussion on the connections between social sciences and life sciences. Interdisciplinarity is a buzzword that may still require conceptual clarification, and this is a task that is now very much underway (see e.g. Schmidt 2007, Schmidt 2011; Alvargonzález 2011. See also resources at http://www.transdisciplinarity.ch). Elsewhere, scholars have begun to think critically about the emergence of a self-consciously interdisciplinary practice within the modern academy (see e.g. essays gathered in Stehr and Weingarten 2000, and in particular, see Maasen's [2000] reflections in that volume on the Centre for Interdisciplinary Research (ZiF) in Bielefeld). Interdisciplinarity itself has a history almost as long as most disciplines – moving from the 'unity of science' movement in the 1930s

Table 1. Differences between archetypal life sciences and social sciences

	Social Sciences	Life Sciences
Object of interest	Sociality, or human social behaviour	Organic life
Pace of change	Slow (but usually careful?)	Fast (but sometimes hasty?)
Costs of research structure	Usually low	Often high
Methodological strategy	Anti-reductionist	Reductionist
Interest in data	Quality (usually)	Quantity (almost always)
Epistemic and popular prestige	Low	High
Role of novel technology	Rarely used	Predicated on
Role of language	Language matters	Language is a vehicle only
Political and ideological commitments	Generally explicit (but sometimes not)	Always implicit (although salience frequently rejected)
Sample sizes	Small (but concept often rejected)	Large (usually, but not always)

and 1940s to the 'knowledge society' of the 1990s (e.g. Gibbons *et al.* 1994) – and this should make us think carefully about its re-emergence today.

Alongside this literature, however, there is an emerging move within some of the more self-consciously innovative parts of contemporary theorising to re-engage an older biological and social holism – represented, for example, by the re-printing of works like Kurt Goldstein's *The Organism* (1995/1934) and Jacob von Uexküll's *A Foray into the World of Animals and Humans* (2010/1934) (see e.g. Wolfe 2009 or Haraway 2007 for contemporary discussions and examples). While not always an easy recourse to interdisciplinarity as such, this move still stands in frank opposition to the more traditionally 'critical' attitudes of many social scientists to the biological sciences, which may have stood in the way of collaboration in previous eras. Arriving in tandem with an emerging interest in 'the social' within the literature in some areas of the emerging life sciences (e.g. Caspi and Moffit 2006, Lieberman 2006), this may represent a new conceptual space for collaboration between the life sciences and the social sciences.

Of course, as even this brief indication makes clear, there is already exciting collaboration underway between these domains, and also already many efforts towards interdisciplinary understanding – from sociologists who urge a constructive attention to new developments in the neurosciences (TenHouten 1997), to psychiatric neurobiologists interested in the effects of the environment on the genome (Hyman 2009). Self-consciously interdisciplinary degree programmes (such as University College London's BASc) and research centres (such as the Centre for Genetics and Society at UCLA) capture the same spirit. What participants at the workshop agreed, though, is that while intentions may certainly be 'good', there are also collaborations between the life sciences and the social sciences that many would frankly regard as 'bad' or 'ugly,' and not for conservative reasons. These are not stable terms, and we provide no taxonomy here – but in using descriptors like 'good,' 'bad' and 'ugly,' we nonetheless try to privilege collaborations in which, for example, the interdisciplinarity is premised on a spirit of mutual understanding and enthusiasm (and not on one providing a service to the other); in which the mutual intellectual engagement is authentic and sustainable (and not 'hit-and-run', or 'window-shopping'); in which the other's literature is understood well (and not trivially); in which contests within other disciplines are confronted (and not elided); in which what is sought is knowledge of an object (and not notoriety of an investigator); and perhaps most importantly, in which potential collaborators come together through a sincere attempt to understand the intellectual contexts in which one another's perspectives have taken shape, and also in which those perspectives have come to make sense. It is in trying to understand the elements of – and the obstacles to – *this* kind of engagement, that the workshop finally addresses itself. We turn now to some empirical examples of inter-domain collaborative research.

3.
Case Studies of Inter-Domain Collaboration

3.1 A Large-Scale Genome-Wide Association Study (GWAS) of Educational Attainment – Lessons from the Social Science Genetics Association Consortium (SSGAC)

Philipp Koellinger
Erasmus University Rotterdam, The Netherlands

Objectives and methodological approach of the project

The SSGAC was launched in February 2011 at a workshop in Boston with the objective to facilitate studies that investigate the influence of genes at the molecular level on social-scientific behaviours and outcomes using large genome-wide association study meta-analyses.

Two major motivations led to the establishment of the consortium. First, the insight that the discovery of novel genetic variants that are associated with social-scientific behaviours and outcomes requires extremely large datasets that can only be achieved through cooperation. Second, social scientists need the expertise and support of other scientific disciplines (e.g. genetic epidemiology and complex genetics) to study the genetic architecture of human behaviour.

The potential benefits of the SSGAC are (1) the possibility to discover truly novel insights into human behaviour and biology and (2) the possibility to discover indirect causal pathways from genes to medical outcomes that are mediated by behaviour and environment.

The pilot project of the SSGAC, which is now nearing its completion, is a large-scale GWAS meta-analysis on educational attainment. Educational attainment is a key variable both in the social sciences and in medical research. It is measured in most genotyped cohorts, it is moderately heritable, and it can be standardised across countries and cohorts using the ISCED classification scheme. However, it is biologically distal and likely to be highly polygenic, which necessitates an extremely large sample size for a genetic discovery study using GWAS.

The composition of the project

The consortium is led by three economists (Daniel Benjamin, David Cesarini and Philipp Koellinger) who are supported by an advisory board that comprises leading experts in bioethics (Michelle Meyer), economics (David Laibson), epidemiology (Albert Hofman, George Davey-Smith), psychology (Robert Krueger), sociology (Dalton Conley) and statistical genetics (Peter Visscher). An overview of the participating cohorts and people can be found on the website of the consortium, http://www.ssgac.org.

Forty-four different cohorts from around the world contributed GWAS data to the discovery stage of the project on educational attainment, yielding a sample size of N = 104,328. Many of the participating cohorts have a medical background and research focus, while others have a long tradition in behavioural genetics research (e.g. various twin registries). Three centres where involved in the meta-analysis of the results: Erasmus University Rotterdam (in particular Niels Rietveld, PhD student of Philipp Koellinger, both economists), the Queensland Institute for Medical Research (Sarah Medland and her PhD student Nico Martin, quantitative genetics), and the University of Minnesota (Jaimie Derringer, psychology). The three centres worked independently and cross-checked their results.

Contributions and degree of integration of the disciplines

The collaboration and integration of the various disciplines in this project is very high. It ranges from study design, data sharing, and data analysis to regular conference calls (to give an indication, seven calls between the start of the project in February 2011 and February 2012) and the joint writing of manuscripts. Furthermore, many participants of the consortium met twice in 2011 at workshops that were organised by the PI's in Boston (February 2011) and Los Angeles (October 2011), supported by grants of the US National Science Foundation and the US National Institute of Health. Furthermore, the key organisers and analysts talk to each other on a regular basis via telephone conferences and Skype and meet each other on a regular schedule, despite the fact that this often requires travelling long distances and working at inconvenient hours.

The spirit of the interdisciplinary collaboration in the SSGAC is that the PIs of the consortium (Benjamin, Cesarini, Koellinger) want to learn and to apply best-practice methods to analyse genetic data from the medical world and to apply them, together with the very strict quality criteria in medicine, to social science outcomes. In return, we offer our medical colleagues opportunities to look at novel outcomes of interest and a potential to gain a better understanding how the interaction of genetic predisposition, individual behaviour and the environment can influence medical outcomes.

Experiences and outcomes

The discovery stage has been completed. Several genome-wide significant loci ($p < 5 \times 10^{-8}$) and dozens of suggestive loci ($p < 10^{-6}$) have been identified. The second stage of the project will test if these loci replicate in other, independent cohorts that have GWAS data, with the objective to have 80% statistical power to replicate the top hits. This requires a replication sample size of N > 20,000. Thirteen additional cohorts have joint the project for the replication stage already, with a combined sample of N ~25,000. Results of the replication stage were expected in mid-2012.

We have had extremely positive experiences with the interdisciplinary collaboration in this project. The frequent interactions of the leading scientists in this project from different fields are characterised by curiosity, mutual respect for each other's expertise, and a joint dedication for scientific excellence.

The price for carrying out such a large-scale, interdisciplinary project is that a significant amount s of administration is required. Furthermore, we ran into quite a bit of scepticism about genetic research in the social sciences, which were motivated by ethical concerns, misunderstandings, problems with IRB approvals in some studies, and sometimes also a lack of interest to look beyond one's own, narrow field.

Furthermore, we do experience quite drastic differences in publication cultures in the social sciences (in particular economics) and the medical sciences (in particular genetic epidemiology). In economics, there is as yet no real appreciation for the specific methodological challenges of genetic discovery studies and editors are reluctant to publish null-results, even if they are based on methodologically well-designed studies. This has changed in genetics journals recently. Furthermore, economics journals are not used to massively co-authored papers; the journals are often extremely slow in their refereeing processes and often lack a network of competent reviewers who have the capacity to evaluate this interdisciplinary research adequately. Again, the opposite is true in genetic epidemiology and related fields. This creates impediments to publishing this work in economics journals and limits the diffusion of knowledge. Furthermore, this creates severe problems of incentive for young economists since many universities do not reward interdisciplinary publications in their career evaluation processes (e.g. "economists should publish in economics journals", "I have never heard of a journal called Nature Genetics").

Lessons learned

Interdisciplinary collaboration is the *sine qua non* for this newly emerging research field. Important ingredients for success are having an open mind, mutual respect across disciplines, a joint vision of what "good science" is, and a willingness to learn from each other. Frequent contact of the key players via telephone, workshops and physical meetings is required. Furthermore, an efficient and professional project management is necessary. The barriers for this type of interdisciplinary research are primarily institutional (e.g. lack of clear career trajectories for young researchers in this field, different publication cultures and incentive schemes across disciplines, lack of sufficiently broad IRB approvals).

3.2 Social Epidemiology and the Whitehall II Cohort

Eric Brunner
University College London, United Kingdom

Whitehall II is a cohort study of health and ageing based at University College London. Now in its 27th year, the study of 10,308 men and women was set up by Michael Marmot in 1985 to extend understanding of the causes of social inequalities in coronary heart disease (CHD) and other important health outcomes. The graded association between higher socioeconomic position and lower all-cause and CHD mortality had already been demonstrated in the original Whitehall study of 17,500 male civil servants begun by Geoffrey Rose and Donald Reid in 1967 as a cardiorespiratory screening cohort, in the period that the CHD epidemic was reaching its peak. Rose's influence continues today in public health thinking about high risk and population-wide strategies of prevention, and Marmot applied that perspective, grounded in the belief that the distribution of risk within a population can potentially be shifted. A range of upstream socioeconomic and psychological measures was added to the then more usual set of downstream behavioural and biomedical measures collected in cohort studies.

Whitehall II extended the earlier findings to women, who made up one-third of the age cohort (35–55 years) of civil servants at its baseline in the mid-1980s, and documented stepwise social patterning of incidence for many causes of morbidity, both physical and psychological. The study showed that wider determinants such as low perceived control at work and influences from childhood as well as biological and behavioural factors contribute to health inequalities. Evidence from Whitehall II and other studies helped to place the social determinants of health firmly on the public health policy agenda.

Integration of academic disciplines

The beliefs and practice of those working in the emergent discipline of social epidemiology are somewhat different from those in clinical epidemiology. The notion of causation is extended outside the body to encompass concepts such as social class that clinical and lab scientists are likely to regard as an abstraction beyond their remit. The belief in the importance of social influences on health is succinctly expressed in the question 'how does your social position get under your skin?' This question underlies many analyses using the Whitehall II cohort that focused on the putative causal effects of psychosocial exposures on cardiovascular risk factors. At the same time, epidemiologists, regardless of their persuasion concerning the validity of studying 'social determinants', share a common belief that useful knowledge can be acquired by studying the distribution and causes of health and ill-health in populations, for example by harnessing the variation in risk factor levels in sub-groups and comparing disease risk between those sub-groups. It is clear that at least to some extent that epidemiology is a social science, and that argument is especially strong in the case of social epidemiology where the risk factor constructs are explicitly sociological and social psychological in their nature. Whitehall II draws the constituent social and biomedical disciplines together in a pragmatic attempt to answer questions that are inherently interdisciplinary.

Whitehall II is thus largely built on collaboration and integration across conventional academic disciplines. Jerome Kagan in his book *The Three Cultures* (New York, Cambridge University Press, 2009) offers a rubric for thinking about the distinctions between the cultures of natural and social science. Among the several themes is 'vocabulary and the preferred set of explanations'. Here, a fascinating pointer emerges to the hybrid nature of the study's outputs. Old academic boundaries are often crossed for example in studying the relation between chronic psychosocial stress at work and risk of diabetes, but issues of generalisability test the shared framework of causal beliefs. Simply, is such an association a universal one, implying that psychological stress is linked directly and biologically to progressive failure of glucose homeostasis, or is the preferred explanation one founded in context, implying that the cultural specificities of the study lead participants to indulge in one or more health-damaging behaviours if they feel stress at work? In the latter case, generalisability is limited and the policy implications may differ. Interestingly, the dividing line between preferred explanations does not necessarily correspond to the dividing line between the social and biomedical disciplines.

Barriers to collaboration

Common purpose derived from the shared research agenda fosters cohesion within the study team, but the study must also serve members of the team effectively in the university environment. The gulf between publication impact factors in social and biomedical science is an important issue that distorts the effort of social scientists who are based in a medical school and may be evaluated against common criteria for internal appraisal and external research assessment. Publication impact is a part of the wider problem of career prospects. Valuable

staff may need to move in order to secure promotion. A further substantial issue is differential pay in epidemiology and public health in the UK, at least. Medically qualified staff would not be attracted to academic positions if a clinical salary was not paid. The policy is equitable in medical and surgical subjects but can create an anomaly in non-clinical subjects such as epidemiology, where medically qualified academics may command a clinical salary without the weight of clinical responsibility borne by their colleagues elsewhere in the medical school. There would seem to be a case for reviewing the differential in the pay scales between clinical and non-clinical academics in order to reduce this pay status anomaly.

Conclusion

Tentatively, the Whitehall II study provides a model of successful interdisciplinary working. The quality, including the originality, of the project judged by conventional academic output metrics is certainly consistent with that view, and there is probably a strong circularity to the linkage between quality and success in interdisciplinary research. However, there is work to be done to ensure that institutional structures accommodate the career trajectories of all committed and productive academics regardless of their scientific training.

3.3 Exploring the Behavioural Genetics of Trade and Cooperation – an on-going Interdisciplinary Project on the Genomics and Evolution of Human Social, Time and Risk Preferences

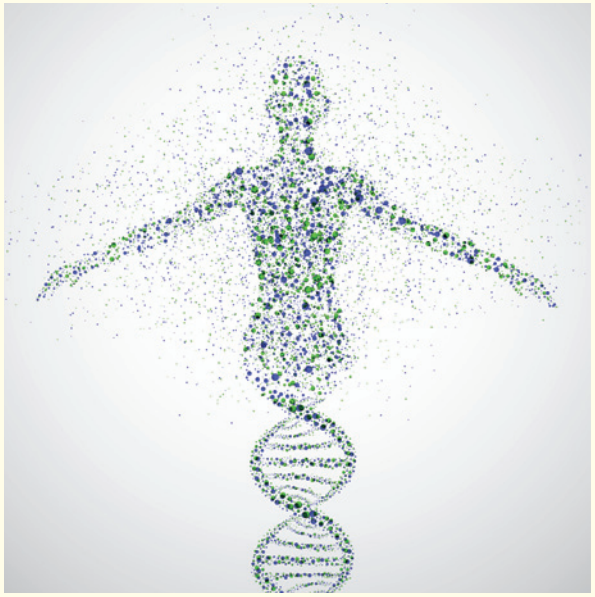
Arcadi Navarro
Universitat Pompeu Fabra, Spain

Objectives and methodological approach of the project

Modern humans are the only primate species to show extraordinary variation in social organisation, kinship, political and trade systems, expression and application of symbolism and so on. This wide range of behaviours includes certain traits that have been crucial to the ability of humans to adapt to different environments and changing circumstances along our evolutionary history. Some examples are intricate cooperative behaviours and clear preferences in the domains of pro-sociality, risk and time. The project aims to explore questions such as: what is the degree of phenotypic diversity in these traits? Do genetic factors contribute to diversity in these traits? If so, how many factors? What might their relative contributions be? How may they be interacting among each other and with environmental contributions? Which is their genetic architecture and how do they differentiate humans from other primates?

To conduct research on these topics we decided to obtain behavioural measures in controlled experiments from a group of humans as large as we could muster within given budgetary constraints. To do so, we put together a team of researchers from different disciplines that would help, first, in selecting the right set of tools (e.g. behaviours to be measured and genotyping techniques to be used) and, second, drawing together the substantial amount of resources that such experimental procedures require. Selected phenotypes included questionnaires (e.g. measuring the Big Five Personality Traits) and experimental tasks (e.g. lotteries to measure risk preferences or versions of the ultimatum game paradigm to measure pro-sociality). Measures are being taken in two different sessions in which subjects spend a total of 6–7 hours in the lab. DNA samples are collected after the first session (via standard saliva kits) and any monetary payments resulting from experimental tasks are made after the last session. Genetic markers are being studied at the whole-genome level using the standard framework of Genome-Wide Association Studies (GWAS).

At the moment of writing this report, we have included ~3,000 subjects in our study. This may be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a modest figure when compared with the largest GWAS (which sometime reach the tens of thousands of individuals), but it is certainly similar to the sample sizes in most GWAS published up to date. A preliminary analysis indicates interesting relationships between some phenotypes and between these and genetic variants. Additionally, minimum heritability estimates are being obtained for some genotypes. We expect to finish the analysis during 2012.

The composition of the project

The project is led by economists (Ernst Fehr, Daniel Schunk) and geneticists (Arcadi Navarro), with the participation of a rather diverse team of researchers with expertise in economics, evolution, statistics, engineering, psychology and other disciplines (including Klaus-R. Müller, Carlos Morcillo, Klaus Schmidt, Urs Fischbacher, Matthias Sutter, Czermak Simon, Daniela Rützler, Christina Strassmair, René Cyranek, Gregor Hasler, Thorsten Dickhaus). All these groups have contributed to different phases of the project (design of tests, sample gathering, genotyping and so on).

The project was constituted in the framework of a call for proposals for ESF's EUROCORES programme TECT (The Evolution of Cooperation and Trading) and, in particular, within the Collaborative Research Project 'SOCOOP' (The Social and Mental Dynamics of Cooperation) led by Herbert Gintis. SOCOOP officially ran between 2008 and 2011, but went beyond the limits of the TECT programme and generated a stable collaboration between several groups, some of which were not included in the original project. In general terms, three centres where involved in sample gathering: University of Zurich (Switzerland), University of Munich (Germany) and University of Innsbruck (Austria), which helped to guarantee the ethnic uniformity of the total sample. Data are being analysed from the economic perspective by the Zurich and Innsbruck teams and from the genomics perspective by the Barcelona team.

Contributions and degree of integration of the disciplines

This is not a multidisciplinary but a clearly interdisciplinary project, with continuous rounds of collaboration and integration between partners with expertise in different disciplines. At all steps (study design, data gathering and distribution, data analysis and interpretation) regular conference calls and meetings have been held (15 such meetings since the start of the project). Furthermore, the project participants talk to each other on a regular basis via telephone conferences and Skype, with several two- or even three-way conferences held every month. Since all disciplines have their own detailed quality criteria, a major effort is required to guarantee the highest possible standards in each field. The whole idea is to address the basic questions outlined above from different perspectives and, in particular, to deploy all the tools that have been developed for medical genomics and behavioural economics in the study of the genetic architecture of human traits of social/economic/evolutionary interest.

Experiences and outcomes

So far, our experience is extremely positive. At a basic level it has been surprising to find out how different are the day-to-day operations in different disciplines. Everything differs: from authorship criteria to result-sharing policies or the perception of time and worth (i.e. when something is 'fast' or 'slow' or when a journal is 'good' or 'mediocre'). Keeping an open mind has been crucial for success and has afforded an increasing feeling of respect and appreciation for each other's work.

Two examples of basic problems that we have had to overcome are related to funding and scientific naivety. First, it has been complicated to fund our initiative. Funding agencies have problems with interdisciplinary projects in the sense that reviewers from the social sciences seem to instinctively mistrust genetic studies; while reviewers from the medical sciences seem to feel that money would be better used if devoted to study health-related traits. A second problem has been the lack of appreciation of the subtleties in one field from the perspective of others. Economists, for instance, didn't really appreciate the large sample sizes and stringent quality control and significance criteria used in genetic studies; while geneticists didn't have a clear idea

about how difficult it is to construct meaningful and consistent phenotypes that can be measured in a controlled and reproducible way.

Lessons learned

To us, the main lesson is that certain questions can only be addressed from a multidisciplinary perspective and that this requires a positive attitude across fields. Some sources of important scientific knowledge will remain untapped unless a serious effort is made by funding agencies to tear down barriers between disciplines.

4.
Findings and Analysis

In this section we outline some of the main strengths that were common to the six cases of collaboration, as well as some of the common problems, to make a series of initial analytical observations about collaboration between researchers in the life sciences and the social sciences (we will draw both on the presentations summarised in the previous section and the discussions at the workshop). As well as being of direct use to social scientists and life scientists who are interested in collaborating with one another, this short analysis is also intended to spur further reflection and research. The analysis is in three parts; the first recognises the problem of talking about a single type of collaboration and uses the case studies to think about different *modes* of collaboration and the different sorts of question to which those modes seem suited. The second part draws out some of the common positive features of the case studies – to see what worked for them, and what may also work for others. In the third part, we set out some of the common issues or problems faced by the collaborators in the case studies. The analysis is appended by a short conclusion that points to some directions for future research in this area.

4.1 Modes and Practices of Collaboration

Throughout the presentation and discussion of the case studies, it was increasingly clear that there were different modes of collaboration both within and among the different cases. It was apparent that different modes matched up with different kinds of questions, and also that they lent themselves to different sorts of problems. Below is a short description and discussion of four more-or-less distinct modes of collaboration that came to light during the workshop. This list is not intended either to be exhaustive or exclusive: a more systematic compilation of case studies than ours would doubtless reveal other modes; perhaps more importantly, most of our individual case studies were stretched across more than one mode, and some may even have switched between modes at different points in their progress. Nonetheless, the four modes identified do provide a starting point for using empirical discussion of life-science/social-science collaboration to differentiate a variety of interdisciplinary routes to common research ends. (See also Schmidt 2008, upon which the following partly draws).

(a) Complexity-led collaboration

"What role do society and politics play in the emergence, spread and experience of psychiatric distress?"

One prominent mode of interdisciplinarity, evident in our cases, begins with a recognition of the inherent complexity of some phenomenon, and proceeds on the basis that such complex phenomena can only be adequately understood if analysed from a variety of perspectives (see Schmidt 2008, on 'object interdisciplinarity' and on 'theory interdisci-

plinarity', both of which have some affinities with this description). Between the life sciences and the social sciences, this complexity often takes the form of a suggestion that there are well-established social phenomena (such as class or poverty) that cannot be fully grasped without an appreciation of their biological effects (such as the spread of disease); *or* that there are biological phenomena (like obesity) that should not be considered or addressed without an understanding of their social co-determinants (for example, food cultures and urban transport policy). Within the workshop, this discussion often took the form of wondering 'how the social gets under the skin' (cf. Hyman 2009). A paradigmatic example of this mode is the 'Whitehall II' study of 'social epidemiology', presented at the workshop by Eric Brunner, which was established to investigate the role of social class in contributing to health outcomes. Particularly in discussion of psychiatric distress, there is an increasing emphasis on wondering what roles society and politics play in the spread of disease – a view of disease that, as Jonathan Mill argued in his presentation on 'epigenetic epidemiology', requires both biological and sociological expertise.

(b) Question-led collaboration

"Can neuroscientific research on oxytocin help us to understand better social-psychology insights about in-grouping and out-grouping behaviours?"

A second mode of interdisciplinarity does not begin with a concern for the complexity of phenomena as such, but moves towards interdisciplinarity in a more heuristic way, through an interest in a particular question or issue that might be productively analysed from more than one angle (this is something like the 'problem-oriented interdisciplinarity' described in Schmidt 2008); *or* in which outstanding problem-areas within one discipline might be resolved or re-analysed by being posed analogously in another discipline. Between the life-sciences and the social sciences, such questions often take the form of considering whether group-level human behaviours (such as favouring in-groups) have correlations at biological levels (using neurochemical or genetic assays); *or* whether biological phenomena (such as childhood neurodevelopmental problems) are marked by predictive environmental measures (such as levels of eye contact). By its nature, collaborative research in this mode tends to be 'bottom-up' – beginning with a question or problem, and integrating disciplinary capacity or expertise as required. Within this workshop, Carsten De Dreu's discussion of his focus on oxytocin in analyses of human behaviour in cooperation and conflict provides a clear example; here, interdisciplinarity was built in as the question progressed – from social psychology to game theory to neuroscience and then to pharmacology. Andreas Roepstorff's discussion of his team's studies of prayer displays a similar logic, in which collaboration is not an end in itself, but is 'naturally' produced through an independent interest in a problem or topic.

(c) Data-led collaboration

"What novel insights could be gained about educational attainment by correlating data from existing GWAS cohorts with the educational level of the individuals who make up that cohort?"

A third mode of collaboration doesn't begin with a particular question or recognition of the world's complexity. Instead, it is premised on the idea that there are many more *kinds* of data available now than there have been previously, and that these various kinds should be used to relate different outcomes or problems that are prominent in different disciplines (cf. Schmidt 2008 on 'method interdisciplinarity'). This often takes the form of looking for a behavioural outcome (like educational attainment) among participants within biological data-sets (such as a GWAS cohort), or for matching up biological information (such as single nucleotide polymorphisms, or SNPs) with sociological or economic categories (like socio-economic status, or SES). Philipp Koellinger's discussion of the Social Science Genetics Association Consortium (SSGAC) is a clear instance of this mode – in which collaborators sought each other out based on access to, and ability to interpret, emerging datasets. Quite distinct from the above, this mode may be more 'top-down' in practice – questions and problems *fall out* of large-scale, quasi-institutional consortia, whose formation is likely to precede the collaboration. The emerging science of epigenetic epidemiology, represented at the workshop by Jonathan Mill, also contains elements of this approach, i.e. in which the existence of data drives the logic of collaboration.

(d) Collaboration across domains

"Is prayer both a culturally and neurobiologically salient category?"

Standing slightly tangential to the previous three, a fourth mode of collaboration evident in the case studies is what we have called, following Sabine Maasen's contribution, collaboration across *domains*. What distinguishes this mode is that the collaboration is primarily (but not exclusively) characterised by a long reach across very different epistemic cultures (Knorr Cetina 1999). Between the social sciences and life sciences, domain-crossing collaborations may be the result of an interest in

a particular problem (such as the consequences of affective neuroscience for social theory), but they also be their own justification, proceeding on the basis that epistemic clash is a form of knowledge production in its own right. The prayer studies of Andreas Roepstorff's group, elements of which were presented to the workshop, likely contains elements of these two strategies – being driven by an interest in connecting research in theology and neuroscience, but also employing a logic within which domain-meeting might be intrinsically productive. The degree to which collaboration crosses domains is as much a quality of different cases, as it is a category in its own right, is open to discussion. Nonetheless, the desire to cross domains for its own sake may drive some specific collaboration between the life sciences and social sciences – although ideas of what constitutes boundary-crossing are contested, and may not be external to the discussions in which they are posed (Star and Griesemer 1989).

4.2 Elements of a Successful Collaboration

Irrespective of mode, however, collaborations that were described in the case studies as 'successful' tended to share a basic set of elements. Below, we set out and discuss some of the most prominent and frequently-cited elements of successful collaboration. Again, this is not an exhaustive or systematic list of 'good' collaboration; but it does flag some of the key elements, human and institutional, of successful social-science/life-science collaborations and that frequently mark 'good' interdisciplinarity.

(a) Tolerance of ambiguity

The fundamental of any successful interdisciplinary endeavour is the ability to tolerate ambiguity. This may be more difficult than it sounds: for individual researchers, it means being prepared to work with people whose research might, for example, look dangerously reductive or trivially broad from the point of view of their own epistemic community; from an institutional perspective, it may mean allowing colleagues and juniors to pursue work that looks fundamentally misguided from the perspective of the discipline. Philipp Koellinger's involvement in the Social Science Genetics Association Consortium (SSGAC) was explicitly premised on his situation in a large, liberal and intellectually cosmopolitan environment – which created the conditions to tolerate the ambiguity necessary for the construction of the SSGAC consortium. Eric Brunner's study was similarly premised on life scientists introducing some ambiguity into their idea of what constituted 'proper science.' Being able to tolerate ambiguity may well mean acting against your own training, instincts and judgement, and it may mean allowing your approaches to be challenged or changed. More to the point, perhaps, really good interdisciplinarity may only be that which can distinguish when this is a risk worth taking, and when it isn't.

(b) Achievement of trust

The case studies are frequently crossed by questions of trust: social scientists willing to collaborate with epigeneticists, as in Jonathan Mill's case, often need to take the expertise of their collaborators on trust alone – and to allow new colleagues to lead them down dark alleys. Philipp Koellinger's colleagues in economics needed to trust that he knew what he was doing with his research time; Carsten de Dreu's case study moved quickly because he was able to take on trust the expertise of colleagues who were well-established in other disciplines; Eric Brunner's team must continue to trust that promotion committees in medical institutions will value a social-science contribution. Clearly, between domains as distinct from one another as the life sciences and the social sciences, much has to be taken on trust. But trust – which is often more-or-less a relation of faith, even when mediated by markers of expertise or trustworthiness – may run against academic norms of evidence. Important to note here is that both the willingness and *desire* to trust are often products of self-reflexivity: researchers frequently seek out trustworthy others, and also become willing to trust, only after critical reflection on the qualities of, and gaps within, their own disciplines and methods. It may be that the propriety of trust is partly a function of the quality of this 'philosophy of one's own science.'

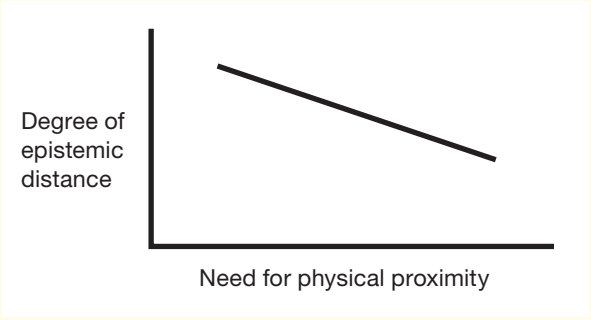
Finally, trust also becomes difficult when particular methods or results are contested within disciplines – who does the would-be external collaborator trust in such instances? Thus, trust is a frequent marker of 'good' collaboration, but it is not difficult to see how misplaced trust or enchantment lies behind the 'bad' and the 'ugly' too. This problem may well be offset by simple human intuition: as one workshop participant put it, knowing 'where the jerks are' might be an essential element of any good collaborative endeavour.

(c) Knowing and managing your proximity

Something evident in the case studies is that questions of proximity are heavily at stake in successful collaborations between life scientists and social scientists. But 'proximity' comes in at least two varieties, and a key issue is getting the relationship

between them right. One main kind of proximity is 'epistemic' proximity. Different parts of both the social and life sciences have different proximal relations to one another: in some ways, for example, and despite differences over sample sizes and fear of false positives, economists may not be so epistemically distant from geneticists with their quantitative, reductive, tactical approaches – compared, for example, to the distance between social anthropologists (qualitative, anti-reductive, contemplative) and neuroscientists. Leveraging epistemic closeness, in this way, seems like a key element of the success of Carsten de Dreu's and Philipp Koellinger's collaborative efforts. But equally, as Andreas Roepstorff's case makes clear, there can be mileage in exploiting epistemic distance. In either case, knowing and managing the degree of epistemic proximity is key: for a self-consciously domain-crossing collaboration, epistemic distance is likely to be much more desirable than it is for a collaboration premised on answering a particular question.

A second kind of proximity that cuts across the cases is physical proximity. This may be geographical (Philipp Koellinger stressed the importance of not relying on the telephone, and of going to meet colleagues in the flesh, so to speak), or it may be architectural (Jonathan Mill noted that the collaborative intent of the Social Genetic and Developmental Psychiatry institute, where his team is based, is designed into the building, through the use of open spaces and strategic crossways). In either, case, however, and while noting the importance of this quality, it is not clear that physical closeness is always necessary or desirable. Indeed, it may be the case that the different proximities (epistemic and physical) have an *interactive* relationship, such that epistemic closeness might be better able to bear physical distance, but also that epistemic distance may require physical proximity. Thus Philipp Koellinger can collaborate with geneticists in Australia, but could a neuroscientist from Andreas Roepstorff's work with a theologian across the same distance? This is the sense in which we suggest that knowing and balancing your proximities is critical for good collaboration.



In any case, an appropriate level of coordination and communication is vital in difficult collaborative endeavours, particularly over physical distances where human contact is often under-nourished. Philipp Koellinger only half-jokingly referred to the SSGAC pilot project as the '1000-email project', underlining the investment of time and communication needed to coordinate large-scale, globally dispersed research programmes.

(d) Resources

Successful collaboration between the life sciences and social sciences is often dependent not only on sufficient funding, but on a particular kind of funding which allows interdisciplinary work to take place. Carsten de Dreu noted that his collaboration was only possible because he had an unmarked sum of research money available to him; without this, funding would likely not have been forthcoming to a social psychologist who wanted to stray into neurochemical research. Adrian Alsop from the UK's Economic and Social research Council (ESRC) similarly noted the importance of funding for 'sandpits' and 'ideas factories' – pots of money specifically aimed at bringing different kinds of researchers into contact with one another. Funding can have a *catalytic* effect on nascent collaborations – and, by extension, funding structures can make interdisciplinary work more or less possible. This is not to argue that life-science/social-science collaboration should be funded without justification, but it is to say that a pre-condition of successful collaboration may well be the availability of financial resources that can be put into ambiguous research at an early stage.

This situation is exacerbated by the speed of development of technology and research within the life sciences – and its generation of further research questions that require interdisciplinary collaboration. If these questions cannot be taken up with some speed – even a risky speed – at an early stage, there is considerable risk of their being left behind by the sheer pace of research, thus producing 'black boxes' that will only become more difficult to re-open as time moves on. This only increases the need for more flexible, faster funding mechanisms, which allows interdisciplinary research to take place more or less simultaneously to the emergence of new kinds of questions. In practice, such catalytic funding may take the form of small amounts of money for specialist, exploratory workshops – as in the case of Philipp Koellinger's SSGAC consortium. But the effectiveness of such funding also requires administrative support, and an institutional environment that is both conducive to, and tolerant of, high-risk, early-stage interdisciplinary conversation.

(e) The independence of quality from collaboration

A frequent (though not essential) mark of good collaboration is that the quality of the research is not dependent on its collaborative nature – that the research is somehow manifestly worthwhile 'in itself.' As Eric Brunner argued on behalf of the Whitehall II study, good research is its own justification, regardless of who or what is involved in its production; in this sense, interdisciplinarity works when the research is good, and fails when it is bad. In some ways this looks like either a tautology or a banality – good research is research that is good – but it is really trying to flag the risk of collaboration becoming (as Philipp Koellinger argued) a quest for cheap notoriety or trendy research. In all of the successful examples discussed at the workshop, by contrast, doing 'good research' was primary to doing 'risky collaboration' – and it was generally agreed that the latter was only meaningful in service of the former, and not for its own sake. Domain-led collaboration may be an exception to this rule – in the sense that the gap is so wide, it may be difficult to breach (at least initially) without specific reference to itself. But in general, good collaboration should transcend itself; interdisciplinarity, in this sense, may simply be replaced by a sense of common purpose, and an enthusiasm for the research which is premised on its intrinsic qualities. This is a factor that, again, cut across all of our cases.

4.3 Issues for Social-Science/ Life-Science Collaboration

As much as these case studies provide positive instances of well-put-together and successful collaborations, all of them either ran into, or manifested, issues and problems that either (potentially) hampered their own work directly, *or* that flagged potential pitfalls for other collaborations. As before, this is not intended to be an exhaustive list, but rather an enumeration of the problems that were most obviously manifest in these cases.

(a) The risk to careers, and other institutional/systemic barriers

As much as interdisciplinary collaboration is exciting, it is also often risky. The most pertinent risk is the risk to individual's career. As Philipp Koellinger noted very frankly in his study, had he and his collaborators been mindful of the progress of their careers, then they would likely never have entered into collaboration in the first place. Eric Brunner also pointed out that social scientists hosted by medical institutions risk not being promoted, or of not having their intellectual contributions recognised in the same way as their colleagues. What these two examples share is that, in both cases, collaboration is put at risk by credit systems that are not just slow to recognise the value and quality of interdisciplinary work, but that in practice (if not by design) may even be actively hostile to collaboration (we note, for example, the dominance of heavily discipline-centric journals in indices of impact, along which young academic careers may well fail or succeed). The risks here are also disproportionately borne by junior scholars, who do not always have the institutional buffers and protected space that allow them to take risks. Even more troublingly, the race to achieve research 'impact' may lead junior scholars down the path of false positives, and towards the kinds of 'ugly' collaboration that garner headlines and notoriety, but that generate little in the way of long-term research impact and in fact may be retrograde for science.

It was also evident in the discussion of these cases, however, that other analogous systemic barriers stood in the way of social-science and life-science collaboration. Again, we note in particular the capacity of funding agencies, still usually domain-or discipline-centric, to recognise, or simply to be able to deal with, the value of collaboration between domains as distinct as the life sciences and social sciences. Another issue that arises repeatedly in the case studies is the cognate problem of access to data: for example, life scientists may find themselves inadvertent gate-keepers of genetic data that could be put to novel (and responsible) use by social scientists, or vice versa. Similarly, national research councils – split along lines of medical, physical, social, and similar areas – do not always make data available to one another. This can be a serious barrier to collaboration. Finally, there was widespread agreement that the general ecology of academic publishing, which, for historical and commercial reasons, is more-or-less split along lines of rigid disciplinarity and domain-led expertise, poses a considerable risk to scholars who move between areas. This is an increasing risk within an emerging research-governance structure that disproportionately values publication in discipline-specific 'high impact' journals – which are themselves gated by discipline-centric cohorts of editors and reviewers. The strong temptation for junior scholars to stay within the narrow lines of their own discipline's epistemic concerns seems clear.

(b) Assessing others' expertise

Another significant risk for these kinds of collaborations is that it is not always easy to assess expertise, evidence and explanations from outside one's own area. As Jeremy Freese pointed out to the workshop, most scholars who strive for inter-literacy have at one point or another seen the same piece of research both lionised and disparaged by researchers from within its own area. This is a particular feature of emerging sciences – such as epigenetics, or the new brain sciences – which are simultaneously both the most promising for collaboration, and the most subject to internal contest. The risk here is, of course, to 'agree' with the expert who conforms most closely to one's own assumptions – which can potentially lead to 'bad' or 'ugly' kinds of collaboration. There is no obvious solution to this problem; in such cases, good collaboration may simply be the product of luck, or of the judicious use of human intuition (see the section on 'trust' above).

(c) Variability of standards

Life scientists and social scientists judge the quality of research, and of method, according to different standards. While this is more an artefact of long-established internal norms, and less a case of uniformly 'good' or 'bad' practice on either side, it nonetheless remains an issue that differing standards can often be translated into value judgements. As Philipp Koellinger points out, economists who are accustomed to small sample sizes, no replication, and little concern for false positives, may have difficulty interacting with genetic epidemiologists who have vast sample sizes, require replication as standard, and have a high awareness of, for example, the multiple testing problem, false positives and publication bias. Conversely, from the perspective of the social sciences, the carefully-produced data and results of the biological sciences may be in need of much deeper contextual and theoretical interpretation.

Variability of standards emerges in other areas of collaboration too, however – such as questions of ethics. For example, Andreas Roepstorff's case study shows how practices judged perfectly acceptable by an expert in one area (in this case, a theologian) looked ethically suspect to a reviewer based in entirely different discipline – who also seemed to struggle to recognise the theologian as the 'ethical expert' in that moment. In both cases, the issue may be less about variability itself, which can be discussed and overcome, but about the mistaking of normal difference for bad practice – which can seriously jeopardise both trust and goodwill, and put the willingness to collaborate at considerable risk.

(d) Mutual incomprehension and attitudes

Mutual incomprehension and suspicion are among the most severe barriers to collaboration between life scientists and social scientists. They are also among those that are the most difficult to address, and even to talk about. Mutual incomprehension may emerge when members of different communities start to engage seriously with one other's data and concepts. In the case of the SSGAC, it was pointed out that having economists manipulate genetic data is like children playing with fire. This issue of social scientists effectively abusing findings, data and methods of the life sciences is well recognised. Less well recognised, however, is the symmetrical problem of life scientists superficially drawing on concepts and knowledge from the social sciences – for instance, as is clear in the case of the Whitehall II study and in the discussion of epigenetic research, 'the social' part of 'social epidemiology' is measured in a way that might not always be meaningful to social scientists, or that may not be sufficiently grounded in longstanding discussions in these domains. Such mutual incomprehension, in many ways an unavoidable aspect of collaboration, can be a barrier to mutual respect, and can thus stand in the way of high-quality interaction.

Cutting across these issues, of course, there is an uncomfortable – but nonetheless unavoidable – disciplinary politics of power and prestige, which is in many ways embedded in the structures of universities. Put crudely, this places the social and life sciences in a hierarchical relationship to one another – which may well be a barrier to collaboration. As Eric Brunner noted, non-practising medical doctors on the Whitehall II study are paid on a clinical scale, well in excess of what the social scientists are paid. Elsewhere, it was pointed out that social scientists who wish to get involved in epigenetics must become familiar with 'the science' – and yet there tends not to be a corresponding assumption that life scientists interested in social epidemiology should become familiar with 'the sociology.' The key point, here, is that collaboration does not always take place on a level playing field; there is an implicit politics to interdisciplinarity that may need to be discussed more openly.

(e) The social science contribution

In a related sense, it is also apparent in these case studies that the precise nature of the social science contribution to these collaborations is not always clear. While some life scientists may see the social science contribution as providing more ecologically valid measurements of the environment, social scientists might wonder if the environment could be

measured at all (to say nothing of the long-established worry about distinguishing the environment for human systems of perception, interpretation, meaning, and so on). Robert Plomin has articulated the social science contribution as a perspective that is intrinsically anti-reductive – within an environment that increasingly demands richer and more complex epistemological tactics. This seems like a positive way forward – although Nikolas Rose also argued that there remains a risk of the social science contribution becoming commodified into a service for life-science research (as, for example, has happened in the case of many practitioners of bioethics). In both cases, and related to the discussion of disciplinary politics above, it is not always clear what the specific social science contribution is, or whether this is valued even when known. This problem may well lie behind much 'bad' or 'ugly' collaboration.

4.4 Conclusion

In sum: there are clearly different modes of interdisciplinary collaboration between the life sciences and the social sciences. While none of these is manifestly better than the others in itself – or, at least, this is not evident in the small number of cases described here – it is likely that some modes are better than others for answering particular kinds of questions. Although we can only gesture at the potential relationship between modes, practices, and questions here, we see the potential for a rich stream of subsequent empirical research, drawing on a much larger data-set, which might produce a greater and more detailed list of modes and better enumerate the kinds of practices suited to those modes. Such a programme of research could direct researchers toward particular modes and practices, based on the kinds of questions and interests that they come with. This seems like a clear priority for future research; it also marks a significant gap, in that participants in our case studies all had to work out appropriate practices heuristically and independently.

We also see more scope for sharpening the distinction between domain-led and non-domain-led collaborations – which may stand in a more fundamental opposition to one another, rather than simply being different ways of addressing the same question. This is not an idle academic exercise: there are cases for arguing both that domain-led collaboration is technically impossible, *and* that domain-led collaboration is the most potentially fruitful kind of interdisciplinary endeavour. Resolving this question seems like another clear priority for the future.

Although we have set out an initial list of characteristics of positive *and* problematic collaboration between the life sciences and the social sciences, there is no reason that this gesture might not be systematised, and the analysis both deepened and formalised. One of the clear outcomes of this workshop is that good collaborations have identifiable, and even measurable, characteristics – as do bad. And while many of the positive points and issues that we identify here – such as the need to foster trust, and the on-going variability of standards – seem like perennials that will appear in any such list, there are also likely many others that our sample-set was simply too small to identify. Finally, there is no reason that such a systematised list of observations could not be translated into a set of recommended collaborative behaviours, and *also* a set of measures for researchers to assess both the kind and quality of their own collaborations, and to make adjustments as necessary. We see this as a clear priority for future research on life science and social science collaboration.

5.
Recommendations

New areas of potential collaboration between life scientists and social scientists are opening up which positively demand engagement across these two domains. It is imperative that biologists and social scientists bury the hatchet, so to speak, for their own mutual benefit and the advance of knowledge about the interdependence of biology and the environment. But it is also critical that conditions be right for new types of collaboration to take place. A number of recommendations could be derived from the case studies and the discussions at the workshop, some quite robust, some more suggestive. Some of these might be generic to all kinds of interdisciplinary collaboration, some more particular to collaborative research between 'archetypal' life sciences and social sciences.

For researchers

(a) Take risks

One of the clearest messages of the workshop was that collaboration and interdisciplinary working are risky for researchers – and especially so for those straddling the life sciences and the social sciences. Nor is this risk equally spread: undeniably, greater risks are carried by younger researchers, and young researchers attempting to transcend whole domains probably accept the biggest risks of all. But it would be an error to think that good collaboration would or could take place in an environment of no risk; indeed, what these cases show is that, at least within current structures, the acceptance of a certain degree of risk is likely a necessary condition of 'good' collaboration, but certainly not of the 'bad' or the 'ugly.' If collaboration is going to happen, researchers need to take personal risks; and it is recommended here – not without trepidation – that they continue to do so. Moreover, it is an obligation on funding agencies to be prepared to back researchers who take such risks. It might be said that funding agencies incline towards the incremental rather than the risky – but provision for bold and ambitious exploration *across* disciplines is essential.

(b) Learn to balance the competing demands of trust and enchantment

Within interdisciplinary work, feelings of trust and enchantment often have a delicate relationship with one another: researchers aiming at collaboration need to suspend some scepticism as a condition of entry, and to put a certain amount of faith (even 'blind faith') in and trust in their collaborator; at the same time, these researchers need to retain their critical faculties, in order not to become overly enchanted with the other – thus allowing reasonable faith to become harmful acquiescence. This is difficult: in one sense, a kind of un-sceptical (indeed, anti-sceptical) trust is both the pre-condition for, and yet also the greatest threat to, high-quality collaboration as we have defined it here. A good collaboration might well be defined as one in which trust and enchantment exist in the correct proportions, as required by the project at hand. And yet there is so simple formula for achieving this. Attention to this difficulty, and to the pitfalls it presents, is surely the first step in any case, and that is what is recommended for researchers here.

For research administrators

(a) Cultivate transcendent seniors; mandate flexible juniors

In some ways, there is an onus upon senior scholars to 'make it okay' for colleagues and juniors to engage in interdisciplinary work. The most obvious way to achieve this, of course, is simply to embody interdisciplinarity in a tranche of self-consciously 'transcendent seniors.' These 'transcendent seniors' would be senior scholars who visibly, but carefully, move across and through disciplines. We advise research administrators to think about ways in which such a cohort would be created, and supported through funding structures (for example, by requiring Co-PIs on large-scale projects, or by creating expressly 'transcendental' research professorships). Simultaneously, by cultivating transcendent seniors, it is recommended that research managers seek ways to more-or-less mandate an emerging cohort of flexible, cross-disciplinary juniors. This might be done, for example, through the requirements (or the ends) of the kinds of funding opportunities that structure the transitional moment between a PhD and a first permanent position.

(b) Be honest about the politics of power and prestige within the contemporary academy

Research managers should accept that the politics of the university will likely structure any researcher's capacity and willingness to collaborate – and also that these forms of politics do not affect everyone equally. Issues of finance, cultural prestige and epistemic salience are largely – but not wholly – outside the remit of research managers. And yet these dynamics, which invest symbolic and epistemic capital in very unequal and not always well-reasoned ways, heavily structure the openings for collaboration, and also the quality of any resulting interaction. It is nonetheless recommended that research managers be alert to this politics when creating strategies for interdisciplinary working – and that they seek ways to address some of its more debilitating side-effects (for example, by looking at the capacity for 'boot camps' in social science approaches, or by looking at the need for differentials between clinical and non-clinical pay scales).

For funders

(a) Make small amounts of seed funding available for pilot studies

Several of our case studies only took place because of the availability of small seed funding, or simply through the good fortune of access to flexible pots of funding. It is recommended that funders actively look at their capacity for providing the kinds of flexible and epistemically generous resources that are crucial to would-be collaborators in the early stages – for example, funding for interdisciplinary collaborative workshops or pilot projects. These pots do not have to be very deep, but they do require width – i.e. that they may be small, but plentiful in number, and therefore low-stakes. To recognise the potentially catalytic effect of small amounts of money in the early stages of collaboration, it is recommended that such funds should be mobile across funding councils. There may even be an argument for not making applications to such pots subject to peer review – which may stymie the efforts of those actively trying to transcend disciplinary boundaries.

In particular, and as a challenge and invitation to researchers within the social sciences, it is recommended that funders specifically invite specifically collaborative grant proposals that are framed by social scientific questions, but questions that are also at stake (even implicitly) within the life sciences. Given the differential in sizes of grants typically given out by life-science and social-science research councils (with the latter usually considerably smaller), this may require more effective and proactive co-operation across funding councils. Such co-operation might take the form of either offering dedicated programmes for collaborative proposals, or to specifically invite submissions from researchers who would typically fall outside the remit of that funding council (in collaboration, of course, with researchers with expertise in the kind of work that the council typically supports). It is also recommended that such cooperation be considered at the institutional level, and within the very structures of funding agencies themselves – for example, through the establishment of explicitly interdisciplinary board and panels within different funding agencies.

(b) Make 'interdisciplinarity' a measure of research quality

One clear route to using funding structures as a spur to greater collaboration is to make 'interdisciplinarity,' 'interdisciplinary impact,' 'interdisciplinary input,' or some other cognate, one of the variables according to which the quality of a research pro-

posal is measured by national funding councils/bodies. This could be done in multiple ways, with either more or less sensitivity, and using a variety of weights – but in any case, the goal would be to reward, in principle, researchers who had written some kind of interdisciplinary component into a grant proposal (similar, for example, to the way that 'impact' is now used as a variable for measuring the quality of research in the UK's Research Excellence Framework [REF]), or even to make 'interdisciplinarity' a necessary component of grant proposals. This would not mean simply adding another kind of capital to the already-complex credit systems within research evaluation frameworks; it would require a more nuanced and intelligent re-interpretation of how credit systems vary across disciplines and domains, and an awareness of how such systems are actually generative of many of the barriers that this initiative of ESF is trying to help to transcend. Thinking about what a universal 'interdisciplinary impact' factor might look like is an important first step to lowering some of these barriers. In any case, reviewers and review panels should be encouraged to have an open mind to interdisciplinary proposals.

(c) Make data more mobile

One of the most consistent spurs to high-quality interdisciplinary work is the availability of data generated within one domain which may then produce new ways of addressing questions in another. But data are not always mobile across disciplines and domains. This may be the product of complex institutional property issues in which, for example, data owned by one research council are not easily available or transferable to researchers working under the aegis of another. It may also be the product of expectations built into 'translational' research, and in particular the expectation that data access needs to be premised on an articulable translational outcome. But, perhaps more fundamentally, this lack of mobility may be the product of thinking about different kinds of data as entirely separable from one another – i.e. that data held in biobanks are fundamentally of a different kind to data held in qualitative-interview software.

It is recommended that, in principle, data produced in one domain should generally be available to researchers in another – but always to be used in a responsible way, drawing on both the spirit and practice of collaboration as we have defined it here. One way to approach this issue is to begin calling into question the ontological boundaries between data produced in the biological sciences and data produced by qualitative research in the social sciences. A qualitative narrative interview, after all, might be seen as just another piece of data about a biological species– and not different in kind to data held on the same species in biobanks, or other more high-tech repositories. This may lead to a practical proposal to start thinking about the creation of 'biobanks' of qualitative data from more interpretive social science disciplines – as a step towards encouraging more mobility between different kinds of bank. But it may also mean simply beginning to recognise and conceptualise social-science data as always-biological data, and biological data as always-social data – as part of a longer-term strategy to encourage new attitudes to data mobility. Such a re-thinking may well help to lower some of the conceptual boundaries that restrict data mobility, or that determine questions of who is qualified to handle either 'biological' or 'social' data.

For policy-makers

(a) Create interdisciplinary and/or inter-domain research councils

One of the most significant barriers to projects such as the case studies described above is the consistent division of national research councils along disciplinary or domain-led lines. This has the direct effect of reducing the number of potential funders for innovative, genuinely collaborative projects – but it also has a more general institutional-agenda-setting effect. For example, the necessity of building a research trajectory within the confines of a discipline-led national research council creates a 'chill' effect for those who are interested in exploring new avenues. It is recommended that policy-makers work to remove this chilling effect. Two potential solutions to this are: (1) creating new national research councils that, in themselves, seek out, promote and fund inter-domain work, from whatever perspective; (2) reserving specific capacity for interdisciplinary research within existing funding councils, such that, for example, a national biomedical research council has a pot that can only be bid accessed by proposals that contain input from some qualitative social science – and vice versa.

(b) Re-think PhD training

PhD training, even more than undergraduate specialisation, is where the most profound disciplinary (and, indeed, sub-disciplinary) selections take place. While this is for good reasons, and while specialisation will of course continue to be valued, it is nonetheless recommended here that policy-makers begin to explore ways that PhD training, in the future, might pay attention to thickness as well as

to depth. This could be achieved, for example, by requiring PhD training programmes to work some kind of 'minor' subject into their research; this goal might also be achieved less formally through the kinds of seminars and training events promoted by, for example, the newly-created Doctoral Training Centres (DTCs) in the UK. While the amount of work already required within the PhD is significant, and many will be concerned about adding another layer of required expertise, the reality is that many PhD students and junior researchers are likely already acquiring some kind of 'minor' specialisation – and what is required, here, is more a recognition and valorisation of this effort, less than something entirely new.

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Annexes

The Good, the Bad and the Ugly': Understanding collaboration between the social sciences and the life sciences

12–13 March 2012, King's College London

Chair: **Nikolas Rose**
Rapporteur: **Des Fitzgerald**

Day 1

Introduction to the workshop: **Sarah Moore**
ESF and its interdisciplinary initiatives:
Eva Hoogland

Welcome to King's College London and introduction to the theme: Two perspectives on collaboration between the life sciences and social sciences
Nikolas Rose and **Robert Plomin**

Policies and practices of interdisciplinary research
Sabine Maasen
Discussant: **Christian Pohl**
Towards a philosophy of interdisciplinarity?
Jan C. Schmidt

Case study 1.
Oxytocin modulates human cognition and behaviour in conflict and cooperation
Carsten De Dreu

Case study 2.
Integrating epigenetic epidemiology into studies of mental illness
Jonathan Mill

Case study 3.
The Social Science Genetic Association Consortium (SSGAC) – Pilot Project on Educational Attainment
Philipp Koellinger

Plenary discussion:
False starts, failures and rivalry between disciplines
Chair: **Adrian Alsop**
Discussant: **Jeremy Freese**
Comment: **Zsofia Viranyi**

Day 2

Case study 4.
The Whitehall II study: a successful interdisciplinary paradigm?
Eric Brunner

Case study 5.
Religious prayers in a neurocognitive framework
Andreas Roepstorff

Panel discussion:
'Whatever works?' Good practice in collaboration between the life sciences and the social sciences
Moderator: **Rifka Weehuizen**
Panel: **Jeremy Freese, Pasqualina Perrig-Chiello, Robert Plomin, Matti Sintonen**

Conclusions of the workshop:
Insights and recommendations

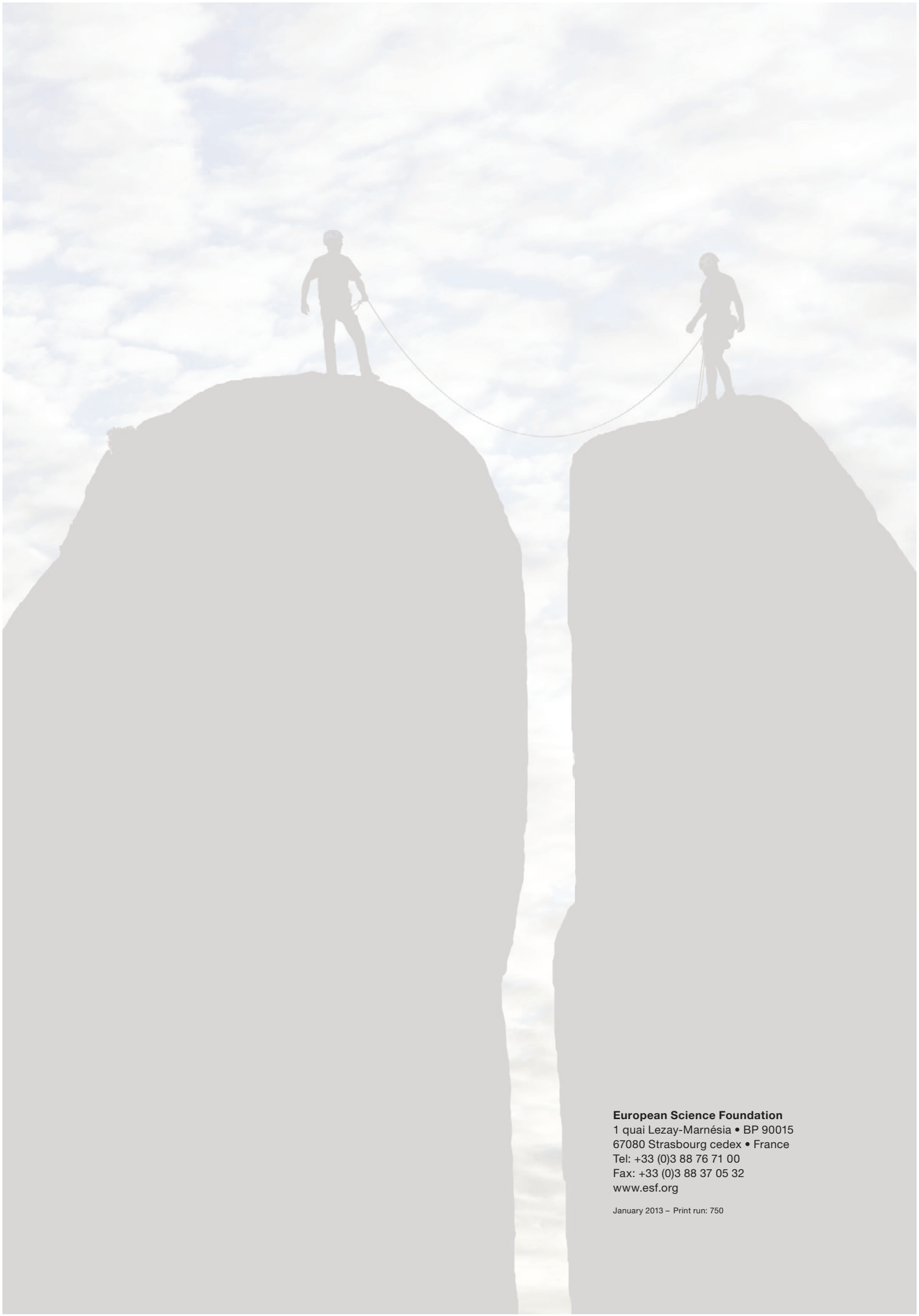
Annex 2. **Workshop Participants**

- **Mr Adrian Alsop**
  ESRC, United Kingdom, and Standing Committee for the Social Sciences, European Science Foundation
- **Dr Eric Brunner**
  Department of Epidemiology and Public Health, University College London, United Kingdom
- **Professor Carsten de Dreu**
  Department of Psychology, University of Amsterdam, The Netherlands
- **Mr Des Fitzgerald**
  Researcher, Department of Sociology, London School of Economics, United Kingdom
- **Professor Jeremy Freese**
  Department of Sociology, Northwestern University, United States
- **Dr Eva Hoogland**
  Humanities and Social Sciences Unit, European Science Foundation
- **Dr Philipp Koellinger**
  Department of Applied Economics, Erasmus University Rotterdam, The Netherlands
- **Ms Sanne Lykke Lundstrom**
  Department of Management Engineering, Technical University of Denmark and Research Unit of General Practice at University of Southern Denmark and Copenhagen University, Denmark
- **Professor Sabine Maasen**
  Programme for Science Studies/Sociology of Science, University of Basel, Switzerland
- **Dr Jonathan Mill**
  Institute of Psychiatry, King's College London, United Kingdom
- **Ms Sarah Moore**
  Humanities and Social Sciences Unit, European Science Foundation
- **Professor Arcadi Navarro**
  Department of Evolutionary Biology, Universitat Pompeu Fabra, Spain*
- **Professor Giovanni Pacini**
  National Institute of Biomedical Engineering (CNR), Padua, Italy, and European Medical Research Councils, European Science Foundation
- **Professor Pasqualina Perrig-Chiello**
  Institute of Psychology, University of Bern, Switzerland, and Standing Committee for the Social Sciences, European Science Foundation
- **Professor Robert Plomin**
  Institute of Psychiatry, King's College London, United Kingdom
- **Dr Christian Pohl**
  Institute for Environmental Decisions, ETH Zürich, Switzerland
- **Professor Andreas Roepstorff**
  Centre for Functionally Integrative Neuroscience (CFIN) and Department of Social Anthropology, University of Aarhus, Denmark
- **Professor Nikolas Rose**
  Department of Social Science, Health & Medicine, King's College London, United Kingdom
- **Professor Jan C. Schmidt**
  Unit for Social, Culture and Technology Studies, Darmstadt University of Applied Sciences, Germany
- **Professor Matti Sintonen**
  Department of Philosophy, University of Helsinki, Finland, and Standing Committee for the Humanities, European Science Foundation
- **Dr Zsofia Viranyi**
  Messerli Research Institute, University of Veterinary Medicine, Vienna, Austria
- **Dr Rifka Weehuizen**
  Humanities and Social Sciences Unit, European Science Foundation

*Due to unforeseen circumstances, **Arcadi Navarro** was not present at the workshop.

Note: Affiliations at time of workshop

ISBN: 978-2-918428-91-6
Printing: Ireg Strasbourg



European Science Foundation
1 quai Lezay-Marnésia • BP 90015
67080 Strasbourg cedex • France
Tel: +33 (0)3 88 76 71 00
Fax: +33 (0)3 88 37 05 32
www.esf.org

January 2013 – Print run: 750