Society in Science – The Branco Weiss Fellowship
Annual Meeting 2010

Abstracts

Stressed to Death: Uncovering Mechanisms of Psychological Stress Effects on Biological Aging

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Aging of the world's population has intensified the need to understand biological aging, the process by which risk for age-related disease and mortality increases over time. Telomeres are DNA-protein complexes that cap the ends of chromosomes and protect against damage to the genome. In humans, leukocyte telomere length has emerged as a potential marker of biological age that predicts risk for age-related disease and early mortality. Accumulating evidence indicates that psychological stress is associated with short leukocyte telomere length. My program of research is dedicated to uncovering mechanisms of psychological stress effects on biological aging. In this presentation, I will introduce my program of research and present my most recent findings.

To date, psychoneuroimmunological research has primarily investigated cross-sectional relationships between psychological factors and immunological outcomes. Conducting research in this vein, I found that childhood trauma, post-traumatic stress disorder and pessimistic personality styles are associated with short leukocyte telomere length. In attempting to uncover the psychological mechanisms by which these diverse psychological factors influence telomere length, I have sought commonalities among them and have directed my attention to *threat perception*. Subsequently, I found that self-reported threat perception in a standardized acutely stressful situation is associated with short leukocyte telomere length. I am now focused on extending this research by devising novel methods to assess threat perception and investigating potential biological mechanisms by which threat perception could influence biological aging. My talk will conclude with the presentation of a comprehensive conceptual model of psychological and biological mechanisms by which psychological stress could accelerate biological aging.

Moving in the Dark – Rats, Men and Beautiful Women – Towards the Sense of Oneself

Arko Ghosh, Institute of Neuroinformatics, ETH and University of Zurich

We go about our daily lives thinking that our actions are based on the information gathered from the outside world, through the sense of vision, hearing, taste, smell and touch. Little do we know how a sense that is stimulated from within the body influences our behaviour. Sensors in the muscles, joints and skin contribute to the sense of oneself or "proprioception". I will introduce my three lines of experiments on the processing of proprioceptive inputs in the cerebral cortex, the seat of higher brain functions. First, I shall explore the flow of information from the body in the rat cortex. Second, proprioceptive inputs generated during a reflexive movement must reach the cortex, and I shall estimate when and how accurately humans can perceive reflexes. Lastly, I will address the consequences on cortical sensory processing of cosmetic BOTOX injections – which is a potent neurotoxin and paralyses the facial muscles responsible for lines and wrinkles. What happens to the sensory information from the body part that can no longer move?

Ecosystem Services in the Anthropocene: Anticipating and Managing Regime Shifts

Reinette Biggs, Stockholm Resilience Centre, Stockholm University

Anthropogenic changes to the biosphere are now a major factor driving Earth system processes, such as the climate and evolution of species. There is evidence that the scale of these changes threaten human well-being by jeopardizing the continued, reliable supply of essential ecosystem services, such as freshwater, food crops and flood regulation. In particular, anthropogenic changes to the biosphere are increasing the risk of crossing tipping points that could trigger catastrophic regime shifts – large, abrupt changes in ecosystem services, such as the collapse of a major fishery. Regime shifts are of considerable concern as they are difficult to predict, costly or impossible to reverse, and can have major consequences for human economies, security and health.

No large-scale synthetic assessments of regime shifts, their impacts on ecosystem services, or the connections among different regime shifts currently exist. In addition, we have a poor understanding of how much of the planet is potentially vulnerable to regime shifts, and how uncertainty about potential regime shifts can be balanced against the use of natural resources for development. My proposed research aims to help address these gaps by contributing theory, methods and understanding that can improve society's ability to anticipate and build resilience to high-impact regime shifts.

In this presentation I will outline the challenges posed by regime shifts, and describe the three research themes around which I plan to structure my research over the coming five years:

- Theme 1: What are the key drivers and ecosystem service impacts of regime shifts? This question will be addressed by developing a comprehensive database of regime shifts in social-ecological systems based on an extensive literature review. The database will be analyzed using methods such as Qualitative Comparative Analysis (QCA), and also be used to investigate connections among regime shifts. The database will be made available online for use by scientists, teachers and managers.

- Theme 2: Which regions on Earth are most vulnerable to regime shifts? To address this question I aim to develop a practical method for mapping and modelling the probability of a regime shift. I plan to pilot the approach using remote sensing data for two important regime shifts in southern Africa – bush encroachment and rangeland degradation.

- Theme 3: How should the risk of a regime shift be traded off against the benefits of ecosystem exploitation? This question will be addressed through the development of a minimal ecological-economic model to explore optimal levels of precaution in the face of uncertainty about a potential regime shift.

Constructing and Deconstructing Diseases in a Dish

Krishanu Saha, Whitehead Institute for Biomedical Research, MIT and John F. Kennedy School of Government, Harvard

New advances in human stem cell biology now permit the derivation of disease-specific induced pluripotent stem cell lines, so called "disease-in-a-dish" models. This is a promising approach for the study of disease phenotypes at the cellular and molecular level, both because such human cell lines may produce more faithful experimental models of disease than can be produced using non-human organisms, and because reprogrammed cell lines can provide a virtually infinite supply of cells without requiring additional tissue donation. To fully realize the potential of such models, we need to understand the molecular and epigenetic determinants that convert one cell type into another, as well as the integration of this technology into emerging translational medicine efforts.

In this talk, I will describe my efforts to monitor and model the somatic cell to stem cell transition quantitatively. I will also demonstrate that human somatic cells can be reprogrammed to distinct pluripotent states, corresponding to the inner cell mass and epiblast developmental stages. Lastly, by monitoring how this new technology integrates with existing approaches of tackling disease in biomedicine, I will describe how this technology has the potential to privilege the laboratory over the clinic in the work of understanding disease, thereby dislocating traditional clinical norms in making sense of and contending with disease. This work helps begin to define experimental and social conditions that allow the development and detection of relevant in vitro cellular phenotypes for a given human disease, putting "personalized" regenerative medicine at the horizon.

Mobilizing Society with a Red Balloon

Riley Crane, Media Lab – Human Dynamics, MIT

Last December DARPA (Defense Advanced Research Projects Agency) unveiled ten red balloons at undisclosed locations around the USA and offered a $40,000 reward to anyone in the world who could find them. Our team found all ten in 8 hours and 52 minutes with a crowdsourcing solution that allowed us to effectively build and query a human sensor network. This talk will examine problems such as these that require coordination beyond the typical scope of crowdsourcing and discuss the combination of incentives with new communication paradigms to drive information cascades in human networks.

Neural and Peripheral Mediators of the Human Social Stress Response

George Slavich, David Geffen School of Medicine and Cousins Center for Psychoneuroimmunology, UCLA

Social stress is a powerful determinant of emotional and physical health. It increases susceptibility to infectious illness, elevates risk for several major disorders, and is a strong, independent predictor of morbidity and mortality. In a recent epidemiological study, for example, males experiencing high levels of stress were 32% more likely to die during a 22-year assessment period than were those experiencing low levels of stress (Nielsen et al., 2008).

Despite these associations, relatively little is known about how social stressors "get under the skin" to affect health. To address this issue, I have used interview- and computer-based measures of life stress, laboratory-based procedures for quantifying neuroendocrine and immune system activity, and fMRI-based methods for assessing neural activity in order to (1) examine what social stressors are most relevant for emotional and physical health, and (2) identify which neural, cognitive, and peripheral mediators are responsible for translating the external social environment into the internal physical environment of disease pathogenesis. This work has revealed that exposure to social stress significantly upregulates inflammatory activity, which is important because inflammation has been implicated in the onset or progression of several major disorders, including asthma, rheumatoid arthritis, cardiovascular disease, and depression. In addition, I have shown that differences in inflammatory responses to social stress may be explained, at least in part, by individual differences in activity in neural regions that process social threat and physical pain (e.g., the dorsal anterior cingulate cortex and anterior insula).

Making Sense of Scents

Andreas Keller, Laboratory of Neurogenetics and Behavior, Rockefeller University, New York

Our perception of odors is in two important ways different from our perception of sights, sounds, and other stimuli. First, odor perception is highly variable; an odor does not have an objective smell but it smells different to different people. Second, odors influence our behaviors and emotional states often without us being aware of a smell. In my research as a Branco Weiss Fellow I address both of these striking peculiarities unique to the perception of odors.

Testing the olfactory perception of a large number of diverse subjects and collecting information (including genomic sequences) about them reveals which aspects of the variability in odor perception are genetic and which aspects are caused by culture and experience. In addition I have developed methods to measure sub-conscious responses to odors and by studying those responses together with genomic sequences I am trying to elucidate why we are so often not aware of the odors that influence our moods and behaviors.

Together these projects give a fascinating insight into how we experience and interact with the odors around us. The way we smell the world is fundamentally different from the way we see or hear the world and a comparison of perception in these different modalities illuminates how our perception of reality is influenced by our sensory abilities.

Social Networks and Disease Dynamics

Marcel Salathé, Center for Infectious Disease Dynamics, Pennsylvania State University

Social networks affect health outcomes in many ways. For infectious disease like influenza, the contact network of human interactions provides the pathways along which pathogens can spread. Theory has demonstrated that the structure of these networks has a strong impact on disease dynamics, but data is severely lacking. I will report the results of a study at a high school where students, teachers and staff were tracked with wireless sensor network technology, and discuss the implications of the study results. In the second part, I will describe work in progress with regard to disease dynamics in the case of non-communicable diseases such as the various cardiovascular diseases. Such diseases are often affected by human behavior, and if human behavior is contagious, social networks will affect disease dynamics of non-communicable diseases as well. Finally, I will briefly report on my recent transition from postdoc to faculty.

Neural and Social Foundations of Prosocial Behavior

Grit Hein, Institute for Empirical Research in Economics, University of Zurich

Societies rely on the ability of individuals to behave in a prosocial manner. Moreover, in our globalized world it becomes increasingly important that prosocial motivations are not only focused on individuals of one's own social group, but extended to individuals from different societies. In my presentation I will discuss human prosocial behaviour from different perspectives. First, I will present results which reveal the impact of self experienced suffering on later prosocial behaviour. Second, I will present evidence showing how altruistic motivation is altered by prejudices towards members of a different social group, how brain imaging methods can be used to uncover hidden prejudices, and how different motivations of prosocial behaviour can be disentangled. Third, I will present future projects which aim at assessing the impact of intervention programs on neural outgroup prejudices, and altruistic behaviour towards members of one's own and other social groups.

WikiGenes – An Experimental Collaborative Platform to Create and Communicate Science in the XXI Century

Robert Hoffmann, Memorial Sloan-Kettering Cancer Center, Computational Biology Center, New York

The anonymous publication of original ideas is as unthinkable as the fine arts without the names of Picasso or Monet. Whenever people collaborate and contribute with their own original ideas then authorship becomes an important factor. WikiGenes (www.wikigenes.org) is the first collaborative publishing system with clear authorship attribution. Based on a unique authorship tracking technology, every contribution to WikiGenes is unambiguously linked to its respective authors. This proof of concept is a central achievement of the project and will have lasting impact on science, education and society [1].

This advance provides a conceptual and technical answer to many shortcomings in the current mode of scholarly communication, which has remained essentially unchanged since the days of Charles Darwin. Currently facts pertaining to specific genes or pathologies, for instance, are scattered over hundreds and

even thousands of different articles and journals. The authorship technology in WikiGenes makes it possible that originators of information –scientists themselves– can publish their insights while contributing at the same time to a body of structured, semantically enriched and integrated knowledge.

WikiGenes had a sound academic debut and its visitor rates have continued to rise and double over the past year. However, if WikiGenes will have lasting impact on scholarly communication –making it more dynamic and accessible to society– will only show over the coming years. It will depend on the will of researchers, funding bodies and policy makers to improve the system. To overcome this phase, I have finally completed years of technical development that make it possible to continuously update and thus maintain the value of WikiGenes as a unique information source – until a critical mass can be reached.

1. A wiki for the life sciences where authorship matters. Hoffmann, R. Nature Genetics 2008, 40(9):1047-1051.

I Clone, She Clones, They Clone

Bruno Reversade, Human Embryology & Genetics Laboratory, Institute of Medical Biology, A*STAR, Singapore

As you read this abstract, nature will have cloned a human being.

Precisely it does so every 50 seconds, each time a pair of identical twins is born.

Breathing a sovereign existence, identical twins are to Dolly-the-sheep what naturally conceived babies are to the first test-tube baby Louise Brown, a challenge to moral authorities, a paradigm shift, a divide between Society and Science.

On what principles have we declared, and banned, intentional human cloning as a hypothetical practice insulting human dignity? Are identical twins de facto illegal human beings because they are clones of one another? What fine line separates natural from intentional human cloning?

Temporal Dynamics and Reliability of Scientific Knowledge

Thomas Pfeiffer, Program for Evolutionary Dynamics, Harvard

Scientific research has changed tremendously within the last few decades. Particularly in the life sciences, we have seen a rapid growth of research activities and the development of technologies that revolutionized the way how scientific hypotheses are addressed. At the same time, the internet made it possible to disseminate large datasets from high-throughput experiments and to create databases that cover the results of research activities of entire research fields; and novel mechanisms emerged for managing, evaluating and negotiating knowledge within and outside the domain of science. These changes set the context of the questions that I investigated in the last five years: What can we learn from large-scale datasets about human decision making and sociological aspects in the practice of research? Are established conventions in designing, disseminating and interpreting research still appropriate? And how can novel, web-based mechanisms to deal with knowledge be employed to optimize the performance of scientific research? Here, I summarize two case studies that use large-scale datasets for analyzing biases and errors due to the sociological nature of research. One of the datasets covers protein interactions and is used to investigate how differences in the popularity of research topics translate into bias. The second dataset covers results from case-control studies on complex genetic diseases and is used to examine temporal patterns in selective reporting. The results from these studies, and from experiments on human decision making in science, allow me to speculate what the most important problems for optimizing the performance of research are. A fascinating novel mechanism that can help optimizing decision making in scientific research is given by prediction markets. I illustrate the functioning of prediction markets and their potential benefits for science using lab experiments and a pilot application for optimizing a genome-wide association study.

SAW – Where Next?

Anne Osbourn, John Innes Centre, Norwich UK

Science, Art and Writing (SAW) is a science education initiative that promotes creativity and aims to dissolve barriers between science and the arts. Learning and exploration are stimulated by visually striking scientific images and through practical science experimentation. The best practice developed over the first five years of SAW projects has enabled the delivery of creative science activities to students of all ages by professional scientists, artists and writers. SAW has received very favourable national and international coverage and has been acclaimed by those involved in pilot projects: scientists, artists, writers, teachers, and – in particular – the students (see www.sawtrust.org for example projects and evaluations). I will summarise the progress that I have made in crystallising the SAW concept and in developing a business plan for the future. I will also review how my experiences of science and the arts and the founding and development of SAW have impacted on my own scientific career and personal development.