Creative Dance: The Inner and the Outer and the Role of Imagination and Creativity in the Artistic Process and Human Development

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Like the other arts, dance is a mirror on the soul; when the soul is not yet capable of manifesting itself, at the very least dance is the mirror of what we have inside ourselves and is able to show itself. This is why, through movement, we reveal who we are and become transparent to the eyes of whoever is attentive and knows how to interpret this truth—a truth we can also see for ourselves. If we are attentive to it, we can use this truth to come closer to our real nature and identity and, hand-in-hand with it, fully move forwards in our lives with our eyes wide open. This is the power of the arts in human development and in awakening awarenesses, because the power to create requires a supremely attentive state that can enable us to achieve a deeper awareness, not only of ourselves, but also of others and of life itself.

Leonor Beltrán earned a Master's Degree in Theatre Studies (except final thesis), Lisbon University Faculty of Literature (FLUL, 2002); a Degree (*Licenciatura*) in Dance, Lisbon Superior School of Dance (ESDL, 1999); and a Degree (*Licenciatura*) in Theatre and Education, Lisbon Superior School of Theatre and Cinema (ESTCL, 2000). Trained in Dance, Piano and Voice at the Lisbon National Conservatory (CNL), she has taken part in Workshops on Historical and Traditional Dances since 1984. She completed an internship at the National Ballet Company's Professional Training Centre (CFP-CNB) and was a member of the Company's Opera Ballet Group; teaches Creative Dance, and Dramatic Expression and Historical and Traditional Dances, at João de Deus Teacher Training College in Lisbon and the Free Courses of the Lisbon National Conservatory's School of Dance (EDCNL); has participated in numerous performances as a ballerina, dancer, actress, singer and puppeteer, and has been responsible for many more as a choreographer and director; has published articles in specialist journals in the fields of dance, theatre, and art-based education. She has also taken part in a number of colloquiums in her specialist area.

Understanding Art through Science: From Socrates to the "Contextual Brain"

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Neuroarthistory is a new approach that uses neuroscience to understand art from all over the world. Data on neural plasticity (how the brain changes as a result of experience or training) is now applied to examine the origins of specific art forms and aesthetic preferences. Research on mirror neurons (which are integral to empathetic engagement) is used to explore different viewer responses. While the emergence of neuroarthistory was facilitated by such recent scientific discoveries, studying human nature in order to understand art has a long history. This presentation will explore one particular strand of this history, focusing on the empathetic engagement with art.

The viewer naturally engages with works of art because of the body movements and facial expressions represented in it. This was already suggested by Socrates. Alberti and Leonardo adapted Horace's writings; "if you would have me weep, you must first feel grief yourself: then.... will your misfortunes hurt me", urging artists to study movements and expressions from life, in order to represent them well and move the spectator. Stressing the science in his argument, Charles Le Brun theorised that the human brain reacts to such representations as if they were the viewer's own movements and expressions. Theodor and Robert Vischer and Friedrich Wölfflin emphasised both the body and the brain in the empathetic reaction not only to art but to other objects and architecture.

The discovery of mirror neurons, first in macaque monkey brains in 1988 and finally confirmed in human brains in 2010, has already been employed by art historians. Jean Pierre Changeux has referred to mirror neurons in the context of action recognition; John Onians has applied the data to explain the emergence of cave art in Europe and David Freedberg has argued that neural mirroring explains emotional engagement with art and challenges the emphasis on cognitive responses which he sees as secondary. The suggestions of these eminent thinkers have led me to develop the concept "contextual brain", presenting a new way forward in discussing art and viewer engagement with art as a product of human nature.

Kajsa Berg finished her BA in Art History, Anthropology and Archaeology in 2004 at the University of East Anglia. There she continued with an MA in World Art Studies focusing on the phenomenology of collecting and completed her PhD "Caravaggio and a Neuroarthistory of Engagement" 2010. She is currently teaching at the School of World Art Studies at the University of East Anglia, where she also continues her research on neuroarthistory and emotional responses to images.

Science Communication: A History and Review

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At first it looks simple. Communication is the transfer of information from A to B. Science communication must therefore be the transfer of scientific information from A to B. This common sense idea has been the dominant view of science communication and has helped to shape debates about "scientific literacy" and the "public understanding of science". However, it is a view that is dependent upon a specific history of science communication and it is an idea that has been challenged in recent years.

What we now think of as science communication has its origins in the nineteenth century. In the early part of the century popular accounts of science often included an appeal to join a Republic of Science in which everyone could participate. By the end of the century increasing professionalization helped define science by excluding the public. This in turn entailed a redefinition of popular science. science which had once been done *by* the public increasingly became that science which is popularized *to* the public. This is now how we commonly think of "science communication", as the transmission of science to the public or, as one scholar puts it, as a form of alms giving.

However, in more recent years the weaknesses of this common view have become acknowledged. Consequently a number of other models of science communication have been proposed, not only to help us in the study science communication but also to guide us in developing policy that relates to science in the public domain. What these new models suggest is that in science communication the public has a part to play too. In the past few years this recognition that the public might have something to say has led to frequent calls for "dialogue" and "engagement". In turn this has found expression in a number of activities such as consensus conferences, citizens' juries, science shops and lay panels to discuss science-based issues.

Nevertheless, even these more nuanced accounts of science communication miss the point, namely that information transfer is only part of communication and not always the most important part. Science is how we make sense of the world, and science communication is one way in which the public make sense of science. If we are able to make sense of the world it is because we are able to *make it make sense* to us within our own sense-making environment or culture. The information a statement contains might remain the same, but how we make sense of it changes with context, medium and the relationship between the people involved.

The central issue of science communication is not just a question of whether we "target" the audience better or making sure we address each audience appropriately. It is more about the relationship between people, about trust, accountability and the nature of expertise. For the public what is important is not so much whether they trust the accuracy of the information but more whether they trust the person that is giving it to them. Who is telling them, when, how and why?

Peter Broks obtained his B.A. and Ph.D. from the University of Lancaster. In 1990 he was a specialist appointment at the University of the West of England, Bristol, to design, develop and teach a new undergraduate programme in "Science, Society and the Media" jointly run by the Faculty of Humanities and the Faculty of Applied Sciences. He has published extensively in the history of science especially as it relates to popular culture and is the author of *Understanding Popular Science* (2006). In August 2011 he left UWE so that he could devote more time to research and writing.

Medical Studies in Coimbra 1911

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This article describes how the way in which the medical sciences were taught at Coimbra evolved over the course of the 19th century, and in the process highlights the relationship between the Faculties of Medicine and Philosophy.

In the mid-19th century the two Faculties were the scene of an effort to develop the way they taught, on the basis of relationships they established with a number of prestigious European scientific institutions.

Research concentrated on the biological, physiological and chemical foundations of life. Therefore, the creation of laboratories of experimental physiology, histology, toxicology and pathological anatomy was the result of the reorganization of the medicine faculty at Coimbra university between 1866-1872, according to the following paradigm replacement: the superficial look at disease was replaced by the study of the inner body, an attempt to understand the symptoms, giving rise to a new paradigm of medicine practice - evidence-based-medicine (EBM). In this article, we intend to sketch an overview of this process with particular focus in the scientific trips undertaken by Costa Simões in 1865.

1. M. C. Burguete [2010] “*Medical Studies at Coimbra in the XIX Century*” edited by Lap Lambert Publications (ISBN: 978-3-8433-6969-5).

2. M. C. Burguete [2010] "Laboratories at the Faculty of Medicine of the University of Coimbra in the XIX Century” *Scientific Research and Essays* **5**(12) 1402-1417 (ISSN: 1992-2248).

Maria Burguete received her Ph.D. in History of Science (contemporary chemistry) from Ludwig Maximilians University at Munich, Germany (2000). She was the very first biochemist to graduate from the Faculty of Sciences in Lisbon (1982), after completing a Bachelor Degree in Chemical Engineering (1979) at the Lisbon Higher Institute of Engineering (ISEL). She is a scientist with and research experience in a wide variety of scientific fields. This diversity enhanced the development of both her interdisciplinarity and a transdisciplinarity. She is now a scientist at Bento da Rocha Cabral in Portugal. She has published seven scientific books and five poetry books, and over 20 scientific papers mostly in history and philosophy of science.

All about Science and Science Matters

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Science is one of the three pillars that support an advanced civilization, East and West. While the other two pillars, ethics/religion and arts, have an extremely long history of at least one million years [1] science, counting from the days of Thales (c. 624-c. 546 BC)—the father of science—has a "short" history of only about 2,600 years. Short as it is, it is long compared to the span of modern science, a mere 400 years or so since Galileo (1564-1642).

The word science was coined in 1867, derived from the Latin *scientia*, meaning "knowledge"—all kinds of knowledge. The idea that science is about systematic knowledge and always involves repeatable and controlled experiments is a misconception, not even correct for modern science. The knowledge about any subject is systematic only at its later and more mature stage; the early stage involves observations and speculations. At the frontier of scientific investigation, it is never systematic but may involve intuition, inductions or deductions. Historical sciences such as astronomy and paleontology do not involve controllable experiments, but advance by comparing their findings to the results of controllable experiments in the lab. Theories form the backbone that chain up the enterprise of science. Also, scientific knowledge consists of two parts: the human-independent part (such as the law of gravity) and the human-dependent part (such as the scientific process, application of science, and science communication). The science of human-related matters is about complex systems (especially the so-called humanities) and remains messy today, while the science breakthroughs in the last 400 years are about mostly simple systems. In all cases, "reality check" is an integral part of science; good science is valued because "it works".

While the tremendous success of modern science did lead to positive results (and important applications like the cell phone), unfortunately, it also led to all sorts of confusions among the philosophers, historians, sociologists, and communicators. The most serious confusion is the exclusion of humans (except medical science) from the domain of science; the historical development of this misconception will be traced in this talk.

Science is about the search for knowledge about Nature, and Nature consists of all material systems including humans and (living and nonliving) non-humans. That humans are part of the natural system is a relatively new recognition. It follows from Darwin's evolutionary theory (published in 1859) and the fact that all material systems are made up of atoms. Note that the existence of atoms was established only 100 years ago due to Einstein's work on Brownian motion (published in 1905). Consequently, most discussions on the contents of science published 150 years ago are simply wrong or misleading.

The failure to recognize the fact that "everything in Nature is part of science"—the premise of the new discipline called Science Matters—has severely damaging consequences for the humankind, such as occurrence of ideological massacres and stagnation in the study of the humanities (leading to the rapid decline of enrollment in these subjects in the universities). Something important is missing in all the disciplines related to science. The remedies will be suggested in this talk.

1. Lui Lam, "Arts: A Science Matter," in *Arts: A Science Matter*, eds. M. Burguete and L. Lam (World Scientific, Singapore, 2011) pp. 1-32.

Lui Lam obtained his B.Sc. from the University of Hong Kong; M.Sc., University of British Columbia; Ph.D., Columbia University. Lam invented bowlics (1982), active walks (1992), and histophysics (2002). He has published 14 books and over 170 scientific papers. He is the founder of the International Liquid Crystal Society (1990); founder and editor of two book series, *Science Matters* (World Scientific) and *Partially Ordered Systems* (Springer).

Planet Earth: Enough for All?

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Planet Earth as a physical reality is limited concerning its size, resources and life time. Exponential demography as well as the intensive use or manipulation of natural resources and its consequences create new challenges and problems to be overcome by all humanity.

In spite of being far from the end of the world for Planet Earth as a planet for a good living, we should start looking for other planets or galaxies that would support life the way we are used to, in order to be possible for the human race (or the human quest) to go on.

The exploration of space is not merely a question of curiosity; we should consider it as a question of survival of the human race. Sooner or later humankind will have to discover other possibilities of living. Therefore, we still have a long way to go towards new directions of the cosmos.

Francisco Félix Machado graduated in History from Lisbon University. He has experience as a radio and television communicator.

Skeptical Philosophy of Science

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Most scientists and most ordinary people would probably agree that modern science has been highly successful at uncovering the fundamental nature of reality. By contrast, most philosophers of science are united by their rejection of this realist view. Despite their many differences, Popper, Kuhn, Lakatos, Laudan, Van Fraassen, Hacking and Cartwright are all agreed that we ought never to believe the basic assumptions of theoretical science.

I shall argue that there is no good basis for this attitude on the part of the philosophers of science, and moreover that their blanket skepticism often serves to obscure the important distinction between good science and bad.

David Papineau has a BSc in Mathematics from the University of KwaZulu-Natal, and a BA and a PhD in Philosophy from Cambridge University. He was President of the British Society for the Philosophy of Science from 1993 to 1995 and President of the Mind Association for 2010. His books include *Theory and Meaning* (1980), *Philosophical Naturalism* (1993), and *Thinking about Consciousness* (2002).

Homo Cosmicus - Natura Fractalis

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The age of the Universe is an estimated 13.75 billion years and the diameter of our observable Universe is about 9.3 x 10^{10} light-years. Assuming the Universe is isotropic, the distance to the edge of the observable Universe is approximately the same in every other direction, with no evidence of any favoured direction of information.

It contains circa 3 – 100 x 10^{22} stars, organised in more than 80 billion galaxies, which then form clusters and superclusters at its large-scale structure.

In the future, the light from distant galaxies will have had more time to travel towards us; hence some regions not currently observable will become visible.

Nothing suggests that the boundary of the observable Universe constitutes a boundary on the Universe as a whole nor do any of the mainstream cosmological models propose that the Universe should have any physical boundaries.

Does a brain sense any of that? Does it perceive any of this? Does it mentally compress/expand Nature's patterns—itself a fractal concept of it?

A Guided Tour Through Reality: from Micro to Macro Cosmos—Patterns Everywhere.

I. Pessôa-Lopes has an academic background in physics (Portugal), astrophysics (UK), and space sciences (Japan) and is affiliated with many scientific and professional bodies worldwide such as The Royal Astronomical Society. She is an international space risks consultant, space policy advisor, science communicator, and published author. Her research interests include fractal geometry, cosmology, chaos and information theory, consciousness, history of Science, and Science Matters.

Motivation Degrees of the Traditional and the Simplified Chinese Characters

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Chinese language is considered one of the hardest languages in the world. Many Western learners admit that remembering the characters takes several times as much time as remembering the grammar and vocabulary. In fact, there are two versions of Chinese characters in use: traditional and simplified. The traditional characters are still in wide use in Hong Kong, Macao, Taiwan and overseas Chinese communities while the simplified characters are in use in Mainland China. Some people believe that the traditional characters are easier to remember, because these characters have more motivation than the simplified ones. But other people complain that the traditional characters are too complicated to write. Is there a way to settle this issue? To find out the answer, "motivation degree" is brought into the analysis.

"Motivation degree" of Chinese characters was first proposed by Pei-Cheng Su in 1994 [1] and has never been used to compare the traditional characters with the simplified yet. One of the reasons is because of the complexity of giving definitions of different character categories. However, Chinese characters are always composed of phonetic components, ideogrammatic components or marks. Based on this idea, the 482 simplified Chinese characters and 503 traditional characters—a simplified character could correspond to more than one traditional character—from List 1 and List 2, which is part of the "Simplified Chinese Characters List" released in October, 1986, can be sorted out. Compared to the traditional characters, for the simplified, the motivation degrees of 10 categories increase and 10 other categories decrease. And the motivation degrees of 11 categories of simplified characters do not change. The ratio of the motivation of the traditional and simplified is 34.79% to 28.23%.

In view of around 80% Chinese characters are phonograms, which composed of a phonetic component and an ideogrammatic component, it is necessary to analyze the motivation degrees of the phonograms. The motivation degree of the phonetic components of simplified characters is 1.78% lower than the traditional ones, and the motivation degree of the ideogrammatic components is 0.78% lower than the traditional ones. The motivation degrees of the simplified characters are truly lower, but it is not as low as some people assumed. Consequently, simplified characters are easier to remember, considering the sententious strokes.

1. Pei-Cheng Su, *The Outline of Modern Chinese Characters* (Peking University Press, Beijing, 1994) pp. 81-83.

Li-Meng Qiu obtained her B.A., M.A. and Ph.D. from Renmin University of China. She is an assistant professor of Chinese language at Zhejiang University, China. Qiu published three papers on simplified Chinese characters and traditional characters, prepositions of ancient Chinese language and excavated texts research. She taught Chinese culture in the Confucius Institute at the University of Rhode Island (2009). Her current research is in teaching Chinese as a foreign language, ancient Chinese grammar and Chinese culture.

The Globalization of Knowledge in History

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Today much knowledge—scientific, technological and cultural—is shared worldwide. The extent to which globalized knowledge existed in the past is still an open question and moreover a question which is important for understanding present processes of globalization. In recent years the migration of knowledge has become an active field of research. The emphasis, however, is—with a few exceptions—mostly on local histories focusing on detailed studies of political and cultural contexts and emphasizing the social construction of science. This emphasis has been extremely useful in overcoming the traditional grand narratives and also in highlighting the complexity of these processes and their dependence on specific cultural, social or epistemic contexts. But they have also induced us to underestimate the degree to which the world has been connected, for a very long time, by knowledge. The result is a rather fragmented picture which tends to neglect the fact that knowledge transmission may have been part of long-term and indeed global processes since very early times and can only be properly understood from a more comprehensive perspective.

The main theme of this talk is that, just as there is only one history of life on this planet, there is also only one history of knowledge. Of course, there have been major losses of knowledge and innumerable new beginnings, and there may be as many perspectives on knowledge as there are cultures, if not people who have lived on this planet. But variety, contingency and catastrophic interruptions are also familiar from the history of life. What counts is that both in the history of life and of knowledge, there is a backbone of historical continuity with cumulative effects on a global scale, effects that are elusive to predominantly local studies and that account for a highly fragmented but nevertheless inexorable global learning process.

Jürgen Renn, Director at the Max Planck Institute for the History of Science, Berlin, since 1994, obtained his diploma (M.S.) in physics (Freie Universität Berlin, 1983) and Ph.D. in mathematic-cal physics (Technische Universität Berlin, 1987). He is Honorary Professor for History of Science, at Humboldt-Universität zu Berlin (since 1995) and Freie Universität Berlin (since 2006); and Adjunct Professor for Philosophy and Physics at Boston University. Prof. Renn is member of various national and international Scientific Advisory Boards and Editorial Boards; and member of the Deutsche Akademie der Naturforscher, Leopoldina (since 2005).

Synchronicity: Approaching the Mind-Matter Dialog

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The Synchronicity concept was first introduced by Carl Gustav Jung in 1952. The connection to natural science was investigated in collaboration with Wolfgang Pauli. Jung discussed the characteristics of a synchronicity event and went deeper on what they called synchronistic thinking, in which the world of the mind and the one in matter communicate among each other [1]. Since then, more than 50 years ago, the concept has been developed in a rather few scientific and philosophical works. To this very day synchronicity is not understood with the required scientific rigor.

A synchronistic event happens when something in the outside reality is connected, by the observer, with his mental subjective experience. This may result in giving additional, unintended meaning to his intentions, thoughts or perceptions. In the history of Humanity synchronicity has been related to important *Serendipity* moments (a special kind of synchronicity). Examples cited in this context are the fall of the apple by Newton, the Eureka moment during Archimedes' bath, the discovery of penicillin etc.

According to Karl Popper science is the art of oversimplification. In the context of Synchronicity this implies the construction of an appropriate language capable of expressing it in a concise yet precise way. The premise is that knowledge, and especially the one about Humanities, needs a special consideration of the way this knowledge is acquired. An important part of how we acquire knowledge is by direct Experience. You can read thousands of books about death, but it is only when you experiment the death of someone close, that you know about it. This is what happens with Synchronicity. The main way one can understand Synchronicity, is when it happens to you. It is this kind of understanding that may lead to a natural neutral language as postulated by Pauli.

In this presentation I will describe how the concept of Synchronicity was first enunciated and follow its evolution till nowadays. The current stage in human knowledge, and in particular in scientific knowledge, may allow us to experiment synchronicity and add individual complementary explanations to our perception of reality.

1. Carl Gustav Jung & Wolfgang Pauli [1952] *Naturerklärung und Psyche. Synchronizitat als ein Prinzip akausaler Zusammenhange.; Der Einfluss archetypischer Vorsstellungen auf die Bildung naturwissenschaftlicher Theorien bei Kepler. Studien aus dem C. G. Jung Institut, IV* (Rascher Verlag, Zurich). [Spanish translation: *La Interpretación de la Naturaleza y la Psique: La Sincronicidad como un Principio de Conexión Acausal*, translated by Haraldo Kahnemann and Enrique Butelman (Ediciones Paidós, Barcelona, 1983).]

Marta Rueda received a degree in agricultural engineer at Valladolid University (1999), with a degree project in collaboration with the etnobotanic department of the Autonomous University of Chapingo, Mexico. She also holds a degree in Economics, marketing specialization at Valladolid University (2001). Since then she has devoted her professional career to the energy business world, working as a commercial manager for Gas Natural Fenosa. Her scientific interests include synchronicity, a term introduced by Jung and developed further in cooperation with Pauli, and mind and matter relations.

What Do Scientists Know!

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Recently the largest refrigerator in the world – the £4.4 billion new instrument operating at CERN, Geneva - was inaugurated. The machine's purpose is to smash together high energy protons in order that scientists can learn about the world of matter, identify what the world is *really* made of, and discover the particle which confers mass on all the other particles. My purpose in this article is not to denigrate this wonderful example of one of mankind's achievements, but to point out a number of problem areas in science which do not get much publicity, and which address the question of what scientists *know*.

These problem areas cut right to the heart of the presuppositions in the language of science used in the previous paragraph. Describing everything in terms of particles, smashing against each other and waiting to be discovered, is the first clue, I believe, to a deeply confused theoretical perspective. I describe two concepts which reflect the notion of science as a process. The first is called *Integrationism* which aims to debunk the "Language Myth" that nature is a world full of objects. The second idea is *Problematology* which sees questions as the fundamental bedrock of science.

The theoretical template behind the Large Hadron Collider is the so-called standard model of particle physics. This is not, as its name suggests, one model but, in fact a large collection of theories with a huge number of free parameters, which make the model almost impossible to test.

Amongst all this confusion the Astrophysicists have admitted that they have no clue as to what approximately four fifths of all the matter particles in the Universe are made of and have asked the Physicists at CERN to see if they can find the particle or particles in their machine.

With the results from this new machine, scientists hope that there will follow a better understanding of the world. I hope that this will be the case, but without a better understanding of meaning in science, confusion will abound.

Nigel Sanitt obtained his B.Sc. in Physics from Imperial College, London and Part III of the Mathematics Tripos and Ph.D. from Cambridge University, where he trained as an astrophysicist at the Institute of Astronomy. He is founder and editor of The *Pantaneto Forum*, a journal which aims to promote debate on how scientists communicate, with particular emphasis on how such communication and research skills can be improved through a better philosophical understanding of science. His book *Science as a Questioning Process* was published in 1996, and he has edited a collection of articles from the first five years of *The Pantaneto Forum* under the title: *Motivating Science.*

Evolutionary Dynamics of Collective Action

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The welfare of our planet stands as a perfect example of what scientists commonly refer to as public goods—a global good from which everyone profits, whether or not they contribute to maintain it. Indeed, reducing the effects of global warming has been described as one of the greatest public goods problems humans have faced, and the one we cannot afford to lose. Unfortunately, individuals, regions or nations may opt to be "free riders", hoping to benefit from the efforts of others while choosing not to make any effort themselves. Cooperation problems faced by humans often share this setting, in which the immediate advantage of free riding drives the population into the "tragedy of the commons", the ultimate limit of widespread defection. Moreover, nations and their leaders seek a collective goal that is shadowed by the uncertainty of its achievement. Such types of uncertainties have repeatedly happened throughout human history from group hunting to voluntary adoption of public health measures and prospective choices.

In this talk, I will discuss an evolutionary dynamics approach to a broad class of cooperation problems in which attempting to minimize future losses turns the risk of failure into a central issue in individual decisions [1]. Resorting to the mathematical tools of game theory, we find that decisions within small groups under high risk and stringent requirements to success significantly raise the chances of coordinating actions and escaping the tragedy of the commons. We also offer insights on the scale at which public goods problems of cooperation are best solved. Instead of large-scale endeavors involving most of the population, which as we argue, may be counterproductive to achieve cooperation, the joint combination of local agreements within groups that are smaller than the population at risk is prone to significantly raise the probability of success. In addition, our model predicts that, if one takes into consideration that groups of different sizes are interwoven in complex networks of contacts [2], the chances for global coordination in an overall cooperating state are further enhanced.

1. Francisco C. Santos and Jorge M. Pacheco, "Risk of collective failure provides an escape from the tragedy of the commons," *Proc. Natl. Acad. Sci. USA* **108** (26), pp. 10421-5 (2011).

2. Francisco C. Santos, Marta D. Santos and Jorge M. Pacheco, "Social diversity promotes the emergence of cooperation in public goods games," *Nature* **454**, pp.213-216 (2008).

Francisco C. Santos (born in Lisbon, 1981) studied Physics at the University of Lisbon and earned his M.Sc. (2006) and Ph.D. (2007) in Computer Science from the University of Brussels. Since 2010, he is a research fellow of the New University of Lisbon and associate member of the ATP group in Lisbon. His interests span several aspects of complex adaptive systems, from the structure of social networks to behavioral evolution and human cooperation. Email: fcsantos@fct.unl.pt; Webpage: http://iridia.ulb.ac.be/~fsantos/; Webpage (ATP group): http://www.ciul.ul.pt/~ATP/.

Discovering Helicobacter

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Before the 1970s, well fixed specimens of gastric mucosa were rare. Then the flexible endoscope was introduced. This enabled gastroenterologists to take numerous well-fixed small biopsies from the stomach. Gastric histology and pathology were clearly demonstrated. Whitehead accurately described it in 1972, including a feature he termed "active" gastritis. This involved only the superficial gastric epithelium, with polymorph infiltration and epithelial cell distortion.

In June 1979 I was examining a gastric biopsy showing chronic inflammation and the active change. A thin blue line on the surface showed numerous small curved bacilli. These were clearly visible with a Warthin Starry silver stain. They appeared to grow on the surface of the foveolar epithelial cells.

Over the next two years I collected numerous similar cases. The changes were often much milder or more focal than the original biopsy, but the main features were usually similar, with chronic gastritis and usually some of the active change. These features could show considerable variation, from near normal to severe.

In 1981 I met Barry Marshall and we completed a clinico-pathological study of 100 outpatients referred for gastroscopy. There was little relation between the infection and the patients' symptoms. Peptic ulcers, particularly duodenal ulcers, were very closely related to the infection. We cultured *Helicobacter pylori*.

In 1986, with Marshall et al, I studied the effect of eradication of *H pylori* on the recurrence of duodenal ulcer. I graded the gastritis (0 – 36) using the features seen with active gastritis. The range was 15 – 35 before treatment. After eradication of *H pylori*, this changed to 5 – 20 within 2 weeks. This provides powerful evidence that *H pylori* causes the active change.

Duodenal ulcer usually occurs in the duodenal cap. Gastric mucosa normally extends through the pylorus. In this study, the proximal border of all ulcers was either definite gastric mucosa, or scarred and consistent with a gastric origin. This suggests duodenal ulcer is either actually a distal pyloric ulcer or gastro-duodenal. It may well arise in the damaged, inflamed and infected mucosa in the position of maximum stress –the lip of the pyloric sphincter.

Robin Warren was born in 1937, in Adelaide, South Australia. He graduated M.B., B.S. from the University of Adelaide in 1961. After training at the Royal Melbourne Hospital, he was admitted to the Royal College of Pathologists of Australasia in 1967. Since then, he was a senior consultant pathologist at the Royal Perth Hospital in Western Australia, becoming emeritus consultant pathologist in 1998.