

RESEARCH HORIZONS



In this issue
**LANGUAGE
SCIENCES**
plus stem cells,
conservation and a
10,000-year revolution



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Research news	3–5
Spotlight:	6–19
Language sciences	
Making sense of language: learning across the lifespan	6–7
The communicative brain	8–9
Smart listeners and smooth talkers	10
Mining the language of science	11
How languages are built	12–13
Music – or language in action?	14
Testing the world's English	15
Island language in a sea of change	16–17
Powerful words	18
Mother tongue, prehistoric father	19
Preview	20–21
Past versus present in an age of progress: the Victorians	
Features	22–30
Cambridge stem cells united	22–23
A conservation leader in the making	24–25
From foraging to farming: the 10,000-year revolution	26–27
Cartographers of the infectious world	28–29
Deep issues: communicating CCS	30
Research online	31
The back page	32



Cover: A new language can at first seem an incomprehensible jumble of sounds until understanding gradually develops; see page 6 for research on language acquisition. Artwork: Christian Faur (www.christianfaur.com/).

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Language sciences



MARK MINISZKO

For some, language is among the key distinctive characteristics of humankind. Others would define language more broadly, as any mode of systematic communication, whether human or otherwise. In either case, the importance of language, and hence of the study of language, is hard to overestimate. Yet few of us are aware of the sheer breadth and diversity of language research.

I suspect that most people, if asked what language research might involve, would probably think first of the study of particular languages: French, Italian, Japanese, Latin, Sanskrit, Medieval Welsh, and so on. With some gentle prodding, our notional (Anglophone) everyman might add English to the list, particularly when reminded that English is the world's most widely studied 'foreign' language, and indeed that Cambridge (through Cambridge Assessment) is one of the world's leading centres for developing tools for the teaching and assessment of English. Pushed to think beyond the specific, we might come next to the study of language as a phenomenon and a practice: that is, to linguistics.

But that is only the start. What about the research that enables us to talk to computers, and enables computers either to carry out our spoken instructions, or to talk back to us (perhaps even in a different language)? And what happens in our own brains when language is produced, processed, responded to?

From philosophy to neuroscience, from phonetics to engineering, language research spans institutions and disciplines right across the University, with over 150 researchers working within the full multidisciplinary spectrum. This issue of *Research Horizons* marks the formal launch of two major initiatives that will help to build on and maximise the benefits of such diverse research by strengthening the cross-disciplinary links.

First, we have created a new Department of Theoretical and Applied Linguistics (DTAL). DTAL is formed from a merger between two smaller existing institutions (the Department of Linguistics and the Research Centre for English and Applied Linguistics), and we believe that it provides a significantly stronger institutional framework in which to develop Cambridge's world-leading linguistics research.

Second, Language Sciences has been designated as one of a select group of University-wide Strategic Research Initiatives. The Language Sciences Initiative is jointly chaired by Dr Henriëtte Hendriks (the first Head of DTAL) and Professor William Marslen-Wilson (Department of Experimental Psychology). It represents an exciting and significant commitment to Cambridge's support for multifaceted inquiry in a field so fundamental to an understanding of our past and present, and to our capacity to shape our future.

Professor Simon Franklin
Head of the School of Arts and Humanities

Magic and medicine

A digital resource dedicated to Simon Forman, the notorious, self-styled astrologer-physician, has been launched to mark the 400th anniversary of his death.

The Casebooks Project, led by Dr Lauren Kassell in the Department of History and Philosophy of Science, is preparing a digital edition of Simon Forman's casebooks, one of the most extensive surviving sets of medical records from the 1600s.

The resource will eventually be home to a complete archive of the 50,000 different consultations that he and his contemporary Richard Napier wrote between 1596 and 1634. Forman's original manuscripts are stored in the Bodleian Library, Oxford, but the electronic edition will be freely available to all, providing users with a detailed insight into the day-to-day lives of the many thousands of people who approached him for consultation. The digital edition, which will appear in December 2011, will combine sophisticated editorial expertise with cutting-edge digital humanities to make these records accessible as never before.

Forman was supposedly so gifted that, according to one account, he even predicted his own death a week before it happened, in September 1611. Yet as much as he was revered he was also loathed, spending parts of

his career in prison for alleged malpractice.

Although he was consulted mainly on health issues, he was also approached with questions about marriage, career prospects, missing people, stolen property, travel plans, legal suits and witchcraft. Each was noted down with meticulous detail because Forman relied on the 'horary' method of astrological judgment, in which a result was determined based on the precise moment at which a question was asked.

"It's an unbelievably rich resource," Kassell said. "Forman compulsively wrote things down – not just in his casebooks, but in thousands of pages of manuscripts. What we see in his records is a full, social dynamic of healing. He was approached by whole families and households, and recorded intimate information about marital infidelity, worries about employment, and all sorts of other social and private matters that fed into people's worries about wellness and wellbeing."

For more information, please visit www.magicandmedicine.hps.cam.ac.uk/



A man designated as Simon Forman, painted ca. 1900

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Cambridge health research receives £110 million

The University of Cambridge and Cambridge University Hospitals have been awarded £110 million to 'boost research and allow the development of ground-breaking medicines'

The funding is part of an £800 million investment by the National Institute for Health Research (NIHR) – the UK's largest ever investment in 'early stage' health research.

Backed by the NIHR, Cambridge is currently one of just five comprehensive Biomedical Research Centres in England. The funding for the Cambridge Biomedical Research Centre (as it was designated in 2007) will be allocated over a five-year period. The money will help fund the development of ground-breaking medicines, treatments and patient care.

In Cambridge, the money will back projects designed to benefit patients with diseases such as cancer and diabetes, specifically targeting advances in diagnosis, prevention and treatment. "The fundamental basis of our research programmes is that they are all designed to benefit patients," said Professor Patrick Sissons, Regius Professor of Physic. "This award makes it possible for us to lead the way in translating fundamental biomedical research into clinical research, and ultimately into advances in healthcare that can be put into practice within the NHS and around the world."

The Cambridge partnership has also been awarded £4.5 million for the formation of a new specialist Biomedical Research Unit

(BRU) focused on dementia – a field in which it was identified as a national research leader. Professor Peter St George-Hyslop, who will lead the purpose-built Cambridge BRU in Dementia said: "£23 billion is spent per year on dementia care in the UK. The Unit will address problems that currently impede effective dementia care by harnessing discoveries from a research pipeline that spans physics, chemistry, chemical engineering, systems biology, molecular and cellular neurobiology, psychology, statistics and medicine." A key aim of the BRU will be to train scientists to be uniquely well equipped to exploit the rich interface between these disciplines.

Dr John Bradley, Director of the NIHR Cambridge Biomedical Research Centre added: "[The new funding] will allow the partnership between Cambridge University Hospitals and the University of Cambridge to build on the substantial achievements of the last five years. A renewal was never guaranteed – this was a competition with the best of England's health research institutions."

For more information, please visit <http://cambridge-brc.org.uk/>

British Academy Fellows

Eight Cambridge academics have been elected Fellows of the British Academy.

The new Fellows, recognised for their research achievements in the humanities and social sciences, are:

- **Professor Robin Alexander**, Fellow of Wolfson College, Emeritus Professor of Education at the University of Warwick and Director of the Cambridge Primary Review.
- **Professor Nicholas de Lange**, Professor of Hebrew and Jewish Studies at the Faculty of Divinity and Faculty of Asian and Middle Eastern Studies.
- **Professor Raymond Geuss**, Professor of Philosophy at the Faculty of Philosophy.
- **Professor Robert Gordon**, Regius Professor of Hebrew at the Faculty of Asian and Middle Eastern Studies.
- **Professor Sylvia Huot**, Professor of Medieval French Literature at the Faculty of Modern and Medieval Languages.
- **Dr Neil Kenny**, Reader in Early Modern French Literature and Thought at the Department of French.
- **Professor Susan Owens**, Professor of Environment and Policy and Head of the Department of Geography.
- **Professor Per-Olof Wikstrom**, Professor of Ecological and Developmental Criminology at the Institute of Criminology.

Gene that controls chronic pain identified

Research lays groundwork for the development of new, targeted pain medications.

Researchers in the Department of Pharmacology have identified a gene, HCN2, that is responsible for regulating chronic, or long-lasting, pain. The research, published recently in *Science*, opens up the possibility of targeting drugs to block the protein produced by HCN2.

Approximately one person in seven in the UK suffers from chronic inflammatory or neuropathic pain. Inflammatory pain occurs when a persistent injury such as a burn or arthritis results in enhanced sensitivity of pain-sensitive nerve endings. More intractable is neuropathic pain, in which nerve damage causes ongoing pain and a hypersensitivity to stimuli. Neuropathic pain, which is often lifelong, is seen in patients with diabetes or as a painful after-effect of shingles. It is also a contributor to lower back pain, and is a common consequence of cancer chemotherapy. Individuals suffering from neuropathic pain often have little or no

respite because of the lack of effective medications.

The HCN2 gene, which is expressed in pain-sensitive nerve endings, has been known for several years, but its role in regulating pain was not understood. The researchers engineered the removal of the gene from pain-sensitive nerves and, in cell cultures, used electrical stimuli to determine how their properties were altered by its removal.

Following their promising results in the cell culture studies, the researchers studied genetically modified mice in which the HCN2 gene had been deleted, and found that this abolished neuropathic pain. Interestingly, they found that deleting HCN2 does not affect normal acute pain (the type of pain produced by a sudden injury – such as biting one's tongue).

Professor Peter McNaughton, the lead author of the study, which was funded by the Biotechnology and Biological Sciences Research Council and the European Union, said: "Many genes play a critical role in pain sensation, but in most cases interfering with them simply abolishes all pain, or even all



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sensation. What is exciting about the work on the HCN2 gene is that removing it – or blocking it pharmacologically – eliminates neuropathic pain without affecting normal acute pain. This finding could be very valuable clinically because normal pain sensation is essential for avoiding accidental damage."

For more information, please contact Professor Peter McNaughton (pam42@cam.ac.uk).

Material designs

Granta Design, a spin-out from Cambridge's Engineering Department, is now the world's largest company in materials information technology.

With a client base across the world, and a supplier of software to some of the top names in industry, Granta Design has achieved an average growth of 30% over the past 10 years.

Launched in 1994 by Professors Mike Ashby and Dave Cebon from the Department of Engineering, the company is the leading provider of university-level teaching resources on materials science and related topics, with its products being used in over 800 universities and colleges worldwide.

The company has also worked with industry since the late 1990s and last year launched interfaces to the 3D computer-aided design (CAD) packages that are the routine

working environment for many engineers. A recent area of expansion has been eco-design, with an increasing focus on materials and their environmental impact.

"We've applied scientific rigour to an area which can sometimes lack substance," said Chief Operating Officer Patrick Coulter. "For example, we help people to quantify the likely carbon footprint over a product's lifetime for a given design. A choice that lowers carbon emissions in one area, such as during use of the product, may increase them elsewhere, perhaps in producing the raw materials. So it's important to base design decisions on a good methodology and hard numbers rather than the latest green hype."

The company's client base includes some of the best-known names in aerospace such as NASA, Rolls-Royce, Boeing, Honeywell, Eurocopter and EADS Astrium. Use of its technologies is spread across a wide range of other sectors, with clients including Emerson Electric, GE, TRW Automotive and Renault F1.

Based in Cambridge, Granta Design has retained its strong links with the University and over the summer it employed its largest ever group of paid interns from Cambridge and elsewhere. "Having these bright and highly motivated people working with us has all-round benefits," said Coulter. "For them it's a taste of the real world, and a chance to get some professional experience under their belts, and for us it's a great opportunity to reinforce our links with academia and spread the word about our products."

For more information, please visit www.grantadesign.com/



Poets of the Caribbean

A new research collaboration aims to put Caribbean poetry back into the classroom both in Britain and the West Indies.

The Caribbean Poetry Project, which is backed by the Poet Laureate Carol Ann Duffy, involves specialists from the University of Cambridge and the University of West Indies. It seeks to revive the study of luminaries of the genre – writers such as Derek Walcott and Kamau Braithwaite – in secondary schools, as well as introducing pupils to new and lesser-known Caribbean poetry.

In Cambridge, a pilot training course involving 17 teachers, many of whom work in ethnically diverse parts of London, has just been completed, and further courses are being developed in Britain and the West Indies for 2012.

The research arm of the Project is focusing on the literature and also on how Caribbean Poetry can best be taught in schools, and a major international conference will be hosted by Cambridge's Faculty of Education next year. Researchers have also linked up with a specialist publisher (Peepal Tree Press) to produce a new anthology of Caribbean poetry.

The long-term ambition is not only to spark the enthusiasm of young readers for Caribbean poetry, but also to use it as a point of access for 11- to 18-year-olds that might inspire them to study more poetry overall.

GCSE and A-Level English syllabi offer limited opportunities for teaching Caribbean poetry. Morag Styles, Professor of Children's Poetry at the University of Cambridge and the academic leading the project, said: "We wish to promote those opportunities and encourage teachers to engage with the exciting range and varied possibilities of this appealing oral, as well as written, literature, which has so many links with popular music and performance."

"We're trying to make teachers feel more confident about using poetry in the classroom in general. Although our particular content is Caribbean, what they learn from this training course can be adapted to the use of poetry in a more general sense as well. This is a way of promoting poetry across the board and the content should be seen that way. After all, the best of someone like Derek Walcott is the best poetry there is, regardless of genre."

For more information, please visit <http://caribbeanpoetry.educ.cam.ac.uk/>



Pay-as-you-go solar power

University of Cambridge spin-out Eight19 has devised a new method of using solar cells to bring electricity to those living off the grid in developing countries.

The company, which was spun out from the Cavendish Laboratory in 2010, develops solar cells based on printed plastic that are ideally suited to small-scale solar lamps and mobile phone chargers.

Solar lamps are widespread in countries such as India and Kenya but their uptake has been limited by the initial purchase price, which is beyond the reach of many consumers. Eight19's IndiGo product combines mobile phone technology with solar power to allow the lamps to be paid for as a service, just like a pay-as-you-go mobile phone.

There are presently about 1.6 billion people worldwide without access to electricity. Instead, they have to make use of traditional fossil fuels such as kerosene for lighting and other purposes. A typical household in Kenya, for example, will spend KSh900 (about US\$10) per month on simple lighting – about a thousand times the cost of the equivalent mains electricity in the West. Moreover, using kerosene can be dangerous (more than one million people are reported to die each year from kerosene-related accidents) and kerosene lighting emits about 190 million tonnes of CO₂ per year. By contrast, solar-powered lamps are safe, sustainable and reliable.

"The problem with almost all renewables, be they wind, solar or tidal, is the upfront cost," said Simon Bransfield-Garth, Chief Executive Officer of Eight19. "By offering solar as a service, customers are able to make a direct transition from their current spend on fossil fuels to lower cost and higher performing solar power."

Eight19's solar cell uses a standard SMS



Demonstrating the IndiGo pay-as-you-go solar cell

message to authenticate the top-up and the customer receives a pass code that they punch into the meter attached to the cell, giving them electricity to light a room or charge their mobile phone.

Field trials of the IndiGo system began in Kenya during September, and larger trials started in October in Kenya, India, Malawi and Zambia. Full-scale manufacturing of the devices will begin in early 2012.

For more information, please visit www.eight19.com/

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Making sense of language: learning across the lifespan



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A new language can at first seem an incomprehensible jumble of sounds until understanding gradually develops

Linguistics – the scientific study of human language – is central to our understanding of the language system and the acquisition of this highly complex system of communication, as Dr Henriëtte Hendriks explains.

Language fundamentally defines and distinguishes us from other living beings. It gives us a tool more powerful than any other to communicate and to organise ourselves, our cultures and the world around us.

Since ancient times, scholars have debated the question of how we come to acquire it. Children typically develop language quickly and, although acquisition continues well into our teen years, the fundamental elements are established by the age of three years. Of course language learning also happens at other times in our lives, whether it's learning a second language at school or after moving to a new country.

The research portfolio of the newly created Department of Theoretical and Applied Linguistics (a merger of the Department of Linguistics and the Research Centre for English and Applied Linguistics) covers language acquisition at all moments across the lifespan, in all possible and imaginable contexts. Researchers specialise in language learning in monolingual and bilingual children and in adults, either in longitudinal studies that take place over many years or in experiments that evaluate how the language system is understood.

An important question in language acquisition concerns the existence of an innate human capability, or 'language faculty', which prepares us for the acquisition of whatever language we encounter at birth. Is there such a faculty? And if so, what underlies it? One suggestion is that this

innate ability develops independently of other cognitive areas; another is that we are equipped with learning mechanisms, such as being able to pick up statistical regularities, which can be applied to many different types of learning, only one of which is language.

"Are some languages 'harder' to learn than others? What characterises language learning at birth versus later in life?"

Then there is the question of the influence of the specific linguistic system we are learning. Are some languages 'harder' to learn than others? Are some features in languages learned earlier or later than others? And what characterises language learning at birth versus later in life?

One way of illuminating the relationship between language and cognition is to examine how first and second languages are acquired, such as by comparing child first-language acquisition with child or adult second-language acquisition. In one project, for instance, an artificial language has been invented to investigate whether understanding features of innate learning can be used to facilitate learning language as an adult (see panel).

Some children grow up in an environment where they acquire two or more languages simultaneously or

successively. Researchers are interested in how children develop grammar in the two languages and also in identifying the differences between typically and non-typically developing children. The latter research is being turned into an off-the-shelf language assessment tool to differentiate between a typical language delay and an underlying learning problem in children.

Looking specifically at English language learning, researchers involved in the English Profile project, which is funded by Cambridge ESOL and Cambridge University Press, are

working to identify criterial features for learners of English at given levels of proficiency, such as errors that learners make only during a given period of learning and then cease to make.

Building on the strengths of the previous institutions, the new department will cover a yet more comprehensive domain of the language sciences and provide stronger theoretical, empirical and interdisciplinary research across the board, from historical linguistics and comparative syntax to language processing and computational linguistics.

Unconscious language learning

One project in the Department of Theoretical and Applied Linguistics is examining unconscious language learning.

When linguists talk about unconscious or implicit language learning, they don't mean learning while you sleep. Rather, they are talking about one of the most intriguing of all mental phenomena: the ability to learn the complex and subtle regularities that underlie a language without even realising.

For children, such 'implicit' language learning seems to happen spontaneously in the first few years of life; yet, in adulthood, learning a second language is generally far from effortless and has varied success.

So marked is the difference between first- and second-language learning – at least when it takes the form of classroom learning – it might suggest that implicit learning makes no significant contribution to learning a second language. Or it may indicate that typical foreign language teaching doesn't take full advantage of the process.

The challenge that faces linguists is how to test whether implicit learning is taking place. How can you differentiate between a person consciously recognising a certain pattern or rule in the language they are learning and the same person unconsciously knowing that something sounds right simply because their brain has judged it to be right?

Artificial language

The new approach to solving the puzzle taken by Dr John Williams at the Department of Theoretical and Applied Linguistics and his collaborator, Dr Janny Leung from the University of Hong Kong, has been to invent an artificial language. In their recently published research, participants were tested to see whether they correctly acquired, over periods as short as one hour, an understanding of patterns embedded within the artificial language.

Do they pick up on the concealed pattern when tested? "The answer is yes," said Dr Williams, whose research was funded by the Economic and Social Research Council. "We found significantly above-chance selection of sentence constructions that were 'grammatically correct' according to the hidden pattern. Yet, the participants had no awareness of what they had learned or how. Moreover, we were able to show learning of the same material by native speakers of two typologically very different languages, English and Cantonese."

Interestingly, picking up the hidden pattern unconsciously doesn't always happen – if, for instance, the hidden pattern is linguistically unnatural. "One explanation could be that certain patterns are more accessible to language learning processes than others. Perhaps our brains are built equipped to expect certain patterns, or perhaps they process some patterns better than others," he added.

Opening the mind

The research provides a window onto unconscious learning processes in the mind and highlights an important element that has practical implications for language teaching. In each test, the learner's attention was directed to the part of the sentence that contained the hidden pattern. By directing attention, it seems that other elements of the sentence construction are picked up unconsciously.

"In a teaching situation, merely teaching the rules of a language may not be the only answer," explained Dr Williams. "Instead, using tasks that focus attention on the relevant grammatical forms in language could help learners access unconscious learning pathways in the brain. This would greatly enhance the speed of acquisition of a second language."

For more information, please contact Dr John Williams (jnw12@cam.ac.uk).

Bilingualism is good for learning

The Cambridge Bilingualism Network (<http://sites.google.com/site/cambiling/>), an outreach activity of the Department of Theoretical and Applied Linguistics, is spreading the message that bilingualism is good for learning. The activity is aimed at parents and teachers, and seeks to dispel misconceptions about bilingualism by facilitating contact between the community and the network of specialists at the University.

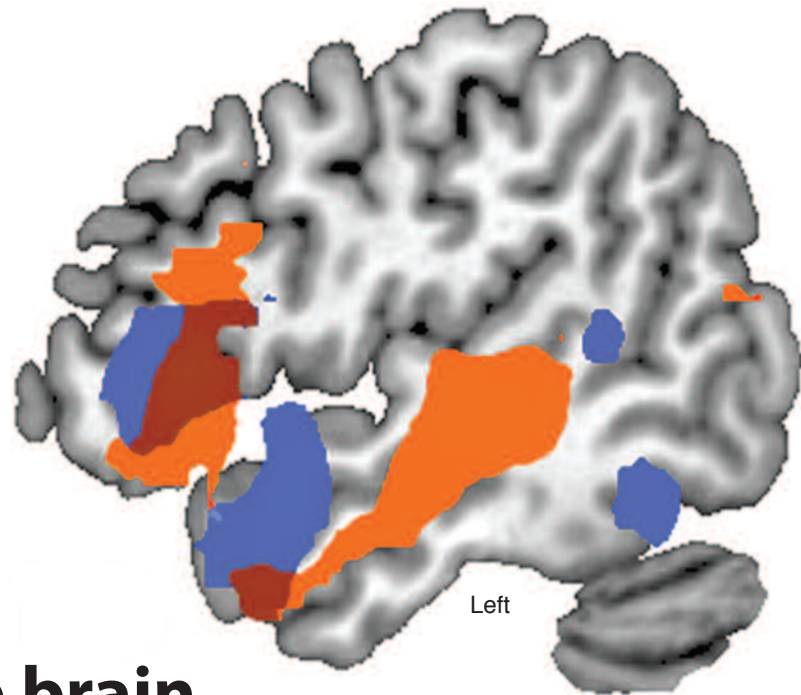
To read more, an online article is available at www.cam.ac.uk/research/



Dr Henriëtte Hendriks

For more information, please contact Dr Henriëtte Hendriks (hpjmh2@cam.ac.uk), Head of the Department of Theoretical and Applied Linguistics (www.mml.cam.ac.uk/dtal/).

What is it about the human brain that makes language possible? Two evolutionary systems working together, say neuroscientists Professor William Marslen-Wilson and Professor Lorraine Tyler.



The communicative brain

The ability to communicate using language is fundamental to the distinctive and remarkable success of the modern human. It is this capacity that separates us most decisively from our primate cousins, despite all that we have in common across species as intelligent social primates.

A major challenge for the cognitive neurosciences is to understand this relationship: what is the neurobiological context in which human language and communication have emerged, and what are the special human properties that make language itself possible?

For the past 150 years, scientific thinking about this relationship has been dominated by the concept of a single, central language system built around the brain's left hemisphere. Pioneering 19th-century neurologists Paul Broca and Carl Wernicke noticed that patients with left hemisphere brain damage had difficulties with language comprehension and language production. Two areas of the left frontal and temporal lobes, Broca's area and Wernicke's area, and the bundle of nerve fibres connecting them, were identified as critical for speaking and understanding language.

Recent research in our laboratories suggests major limitations to this classic approach to language and the brain. The Broca–Wernicke concept captures one important aspect of the neural language system – the key role of the left hemisphere network – but it obscures another, equally important one. This is the role of bi-hemispheric systems and processes, whereby both left and right hemispheres work together to provide the fundamental underpinnings for human communicative processes.

A more fruitful approach to human language and communication will require a

dual neurobiological framework in which these capacities are supported by two intersecting but evolutionarily and functionally distinguishable subsystems. The historical failure to make this separation has, we suggest, severely undermined scientific attempts to understand language, both as a neurocognitive phenomenon in the modern human, and in terms of its evolutionary and neurobiological context.

Dual systems

A strong evolutionary continuity between humans and our primate relatives is provided by a distributed, bi-hemispheric set of capacities that support the dynamic interpretation of visual and auditory signals in the service of social communication. These capacities have been the object of intensive study in monkeys and apes, and there is good evidence that their basic architecture underpins related communicative functions in the human.

In the context of human language comprehension, the bi-hemispheric systems support the ability not only to identify the words a speaker is producing – typically by integrating auditory and visual cues in face-to-face interaction – but also to make sense of these word-meanings in the general context of the listener's knowledge of the world and of the specific context of speaking.

Where we see divergence between humans and other primates is in the domain of grammatical (or syntactic) function. Primate communication systems are not remotely comparable to human language in their expressive capacities. Human language is much more than a set of signs that stand for things. It constitutes a powerful and flexible set of grammatical devices for organising the flow of linguistic information and its interpretation, allowing us to represent and

combine abstract linguistic elements, where these elements convey not only meaning but also the subtle structural cues that indicate how these elements are linked together.

It is the fronto-temporal network of regions in the left hemisphere that mediates these core grammatical functions in humans. This is a network that differs neuroanatomically from those of the brains of other primates, showing substantial increases in size, complexity and connectivity.

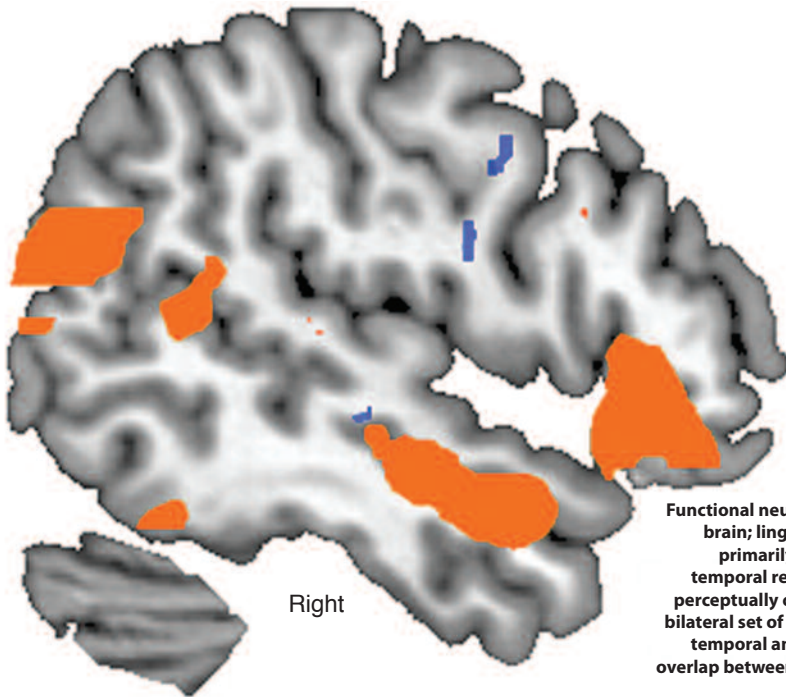
Although it's not yet understood just how these evolutionary changes in the left hemisphere provide the neural substrate on which grammatical functions depend, it is clear that they are essential. When the left hemisphere system is damaged, the parallel right hemisphere regions cannot take over these functions, even when damage is sustained early in childhood.

Critically, however, the left hemisphere system that has emerged in humans neither replaces nor displaces the bi-hemispheric system for social communication and action found in both humans and other primates. It interacts and combines with it to create a co-ordinated process of linguistically guided communication and social interaction.

Functional separability

The most direct evidence for a dual system approach is the ability to separate these systems in the modern human. Using a combination of behavioural and neuroimaging techniques, we have been able to demonstrate this both in patients with left hemisphere brain damage and in unimpaired young adults.

In the research with patients (conducted with Dr Paul Wright in the Department of Experimental Psychology and Dr Emmanuel Stamatakis in the Division of Anaesthesia) we focus on the comprehension of spoken words



Functional neuroimaging of the human brain; linguistically complex words primarily activate the left fronto-temporal regions of the brain (blue), perceptually complex words activate a bilateral set of brain areas mainly in the temporal and frontal areas (orange), overlap between these two distributions is shown in dark red

and spoken sentences. In initial testing, patients perform classic measures of syntactic function, where they match different spoken sentences to sets of pictures. Shown three pictures – a woman pushing a girl, a girl pushing a woman and a woman teaching a girl – patients will correctly match the sentence ‘The woman pushed the girl’ to the first picture but will incorrectly match the passive sentence ‘The woman is being pushed by the girl’ to the same picture. The second sentence requires the use of syntactic cues to extract the right meaning – just using the order of words is not sufficient.

These behavioural tests of syntactic impairment are linked, in the same patients, to their performance in the neuroimaging laboratory, where they hear sentences that vary in their syntactic demands, and where the precise extent of the injury to their brains can be mapped out. When we put these different sources of information together, we see that damage to the left hemisphere system progressively impairs the syntactic aspects of language processing – the more damage, the worse the performance.

Critically, however, the amount of left hemisphere damage, and the extent to which it involves the key fronto-temporal circuit, does not affect the patients’ ability to identify the words being spoken or to understand the messages being communicated – so long as syntactic cues are not required to do so. These capacities are supported bi-hemispherically, and can remain relatively intact even in the face of massive left hemisphere damage.

In work carried out with Dr Mirjana Bozic, then based at the Medical Research Council (MRC) Cognition and Brain Sciences Unit in Cambridge, we have been able to delineate these systems in the undamaged brain, using functional neuroimaging to tease out the different processing regions that are engaged

by speech inputs with different properties.

Listeners hear either words that are specifically linguistically complex (words like *played*, which have the grammatical inflection ‘ed’), or words that make more general demands on the language processing system (words like *ramp*, which have another word, *ram*, embedded in them). Using an analysis technique that identifies the separate dimensions of the brain’s response to these sets of words, we see that the linguistically complex words activate a response component that is restricted to the left fronto-temporal region. By contrast, words that are perceptually complex, due to increased competition between the whole word and the embedded word, activate a strongly bi-hemispheric set of regions, partially overlapping with the linguistic component. Even in the intact brain, therefore, we can see the dynamic allocation of processing resources across the two systems, as a function of their joint roles in the communicative process.

Implications

A dual systems account of the ‘communicative brain’ is likely to have important and illuminating consequences for the sciences of language and its disorders.

In the context of left hemisphere brain damage we can better appreciate – and build upon for rehabilitation – the substantial bi-hemispheric communicative capacities the patient may still possess. In first- and second-language acquisition, we can better understand the learning trajectories that lead to language proficiency in terms of the relative contributions of these two aspects of communicative function.

The approach also provides a new perspective on the variation between languages, where different languages may

load more or less heavily on the different computational resources made available by the two systems. Most importantly, it enables us to clarify and focus the core issues for a neurobiological account of language and communication, a scientific domain clouded by ideology and inconsistency.

“A dual systems account of the ‘communicative brain’ is likely to have important and illuminating consequences for the sciences of language and its disorders.”



Professor William Marslen-Wilson and Professor Lorraine Tyler

For more information, please contact Professor William Marslen-Wilson (wdm10@cam.ac.uk) and Professor Lorraine Tyler at the Department of Experimental Psychology. Professor Marslen-Wilson was previously Director of the MRC Cognition and Brain Sciences Unit, Cambridge.

Human-like performance in speech technology could be just around the corner, thanks to a new research project that links three UK universities.

Smart listeners and smooth talkers

Human conversation is rich and it's messy. When we communicate, we constantly adjust to those around us and to the environment we're in; we leave words out because the context provides meaning; we rush or hesitate, or change direction; we overlap with other speakers; and, crucially, we're expressive.

No wonder then that it's proved so challenging to build machines that interact with people naturally, with human-like performance and behaviour.

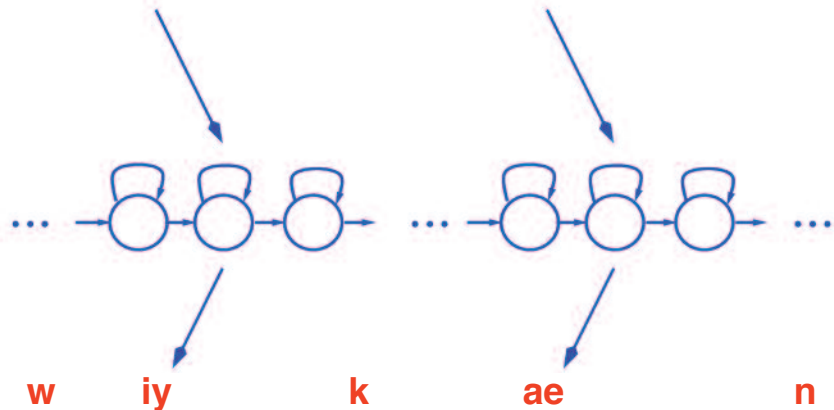
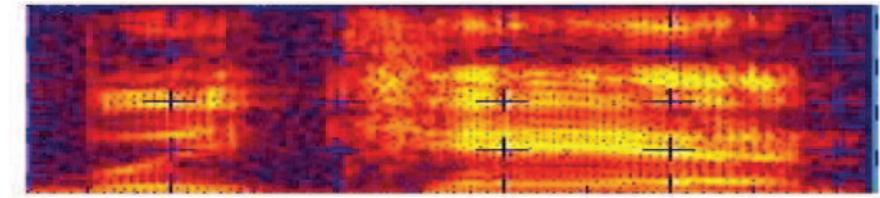
Nevertheless there have been remarkable advances in speech-to-text technologies and speech synthesizers over recent decades. Current devices speed up the transcription of dictation, add automatic captions to video clips, enable automated ticket booking and improve the quality of life for those requiring assistive technology.

However, today's speech technology is limited by its lack of ability to acquire knowledge about people or situations, to adapt, to learn from mistakes, to generalise and to sound naturally expressive. "To make the technology more usable and natural, and open up a wide range of new applications, requires field-changing research," explained Professor Phil Woodland of Cambridge's Department of Engineering.

Along with scientists at the Universities of Edinburgh and Sheffield, Professor Woodland and colleagues Drs Mark Gales and Bill Byrne have begun a five-year, £6.2 million project funded by the Engineering and Physical Sciences Research Council to provide the foundations of a new generation of speech technology.

Complex pattern matching

Speech technology systems are based on powerful techniques that are capable of learning statistical models known as Hidden Markov Models (HMMs). Trained on large quantities of real speech data, HMMs model



Statistical models of speech learn to associate particular speech sounds in context with corresponding portions of audio

the relationship between the basic speech sounds of a language and how these are realised in audio waveforms.

It's a complex undertaking. For speech recognition, the system must work with a continuous stream of acoustic data, with few or no pauses between individual words. To determine where each word stops and starts, HMMs attempt to match the pattern of successive sounds (or phonemes) to the system's built-in dictionary, assigning a probability score as to which sounds are most likely to follow the first sound to complete a word. The system then takes into account the structure of the language and which word sequences are more likely than others.

Adapt, train and talk

A key focus for the new project is to build systems that are adaptive, enabling them to acclimatise automatically to particular speakers and learn from their mistakes. Ultimately, the new systems will be able to make sense of challenging audio clips, efficiently detecting who spoke what, when and how.

Unsupervised training is also crucial, as Professor Woodland explained: "Systems are currently pre-trained with the sort of data they are trying to recognise – so a dictation system is trained with dictation data – but this is a significant commercial barrier as each new application requires specific types of data. Our approach is to build systems that are trained on a very wide range of data types and enable detailed system adaptation to the particular situation of interest. To access and structure the data, without needing manual transcripts, we are developing approaches that allow the system to train itself from a large quantity of unlabelled speech data."

"One very interesting aspect of the work is that the fundamental HMMs are also generators of speech, and so the adaptive technology underlying speech recognition is

also being applied to the development of personalised speech synthesis systems," added Professor Woodland. New systems will take into account expressiveness and intention in speech, enabling devices to be built that respond to an individual's voice, vocabulary, accent and expressions.

The three university teams have already made considerable contributions to the field and many techniques used in current speech recognition systems were developed by the engineers involved in the new project. The new programme grant enables them to take a wider vision and to work with companies that are interested in how speech technology could transform our lives at home and at work. Applications already planned include a personalised voice-controlled device to help the elderly to interact with control systems in the home, and a portable device to enable users to create a searchable text version of any audio they encounter in their everyday lives.



Professor Phil Woodland

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Mining the language of science

Scientists are developing a computer that can read vast amounts of scientific literature, make connections between facts and develop hypotheses.

Ask any biomedical scientist whether they manage to keep on top of reading all of the publications in their field, let alone an adjacent field, and few will say yes. New publications are appearing at a double-exponential rate, as measured by MEDLINE – the US National Library of Medicine’s biomedical bibliographic database – which now lists over 19 million records and adds up to 4,000 new records daily.

For a prolific field such as cancer research, the number of publications could quickly become unmanageable and important hypothesis-generating evidence may be missed. But what if scientists could instruct a computer to help them?

To be useful, a computer would need to trawl through the literature in the same way that a scientist would: reading the literature to uncover new knowledge, evaluating the quality of the information, looking for patterns and connections between facts, and then generating hypotheses to test. Not only might such a program speed up the progress of scientific discovery but, with the capacity to consider vast numbers of factors, it might even discover information that could be missed by the human brain.

The aim of Dr Anna Korhonen and researchers in the Natural Language and Information Processing Group in the Computer Laboratory is to develop computers that can understand written language in the same way that humans do. One of the projects she is involved in has recently developed a method of ‘text mining’ one of the most literature-dependent areas of biomedicine: cancer risk assessment of chemicals.

CRAB: catching facts on chemical toxicity

Every year, thousands of new chemicals are developed, any one of which might pose a

potential risk to human health. Complex risk assessment procedures are in place to determine the relationship between exposure and the likelihood of developing cancer, but it’s a lengthy process, as Royal Society University Research Fellow Dr Korhonen explained: “The first stage of any risk assessment is a literature review. It’s a major bottleneck. There could be tens of thousands of articles for a single chemical. Performed manually, it’s expensive and, because of the rising number of publications, it’s becoming too challenging to manage.”

CRAB, the tool her team has developed in collaboration with Professor Ulla Stenius’ group at the Institute of Environmental Medicine at Sweden’s Karolinska Institutet, is a novel approach to cancer risk assessment that could help risk assessors move beyond manual literature review.

The approach is based on text-mining technology, which has been pioneered by computer scientists, and involves developing programs that can analyse natural language texts, despite their complexity, inconsistency and ambiguity. The tool Dr Korhonen has developed with her colleagues is the first text-mining tool aimed at aiding literature review in chemical risk assessment.

At the heart of CRAB, the development of which was funded by the Medical Research Council and the Swedish Research Council among others, is a taxonomy that specifies scientific evidence used in cancer risk assessment, including key events that may result in cancer formation. The system takes the textual content of each relevant MEDLINE abstract and classifies it according to the taxonomy. At the press of a button, a profile is rapidly built for any particular chemical using all of the available literature, describing highly specific patterns of connections between chemicals and toxicity.



“Although still under development, the system can be used to make connections that would be difficult to find, even if it had been possible to read all the documents,” added Dr Korhonen. “In a recent experiment, we studied a group of chemicals with unknown mode of action and used the CRAB tool to suggest a new hypothesis that might explain their male-specific carcinogenicity in the pancreas.”

The tool will be available for end-users via an online web interface. However, research into improving text mining will continue. One of the biggest current challenges is to develop adaptive technology that can be ported easily between different text types, tasks and scientific fields.

One day, rather than being at the mercy of the flourishing rate of publication, scientists will have at their fingertips a system to work alongside them that will not only point them towards those references that are relevant to their search, but will also tell them why.



Dr Anna Korhonen

For more information, please contact Dr Anna Korhonen (alk23@cam.ac.uk), who has a joint appointment between the Computer Laboratory (www.cl.cam.ac.uk/) and the Department of Theoretical and Applied Linguistics (www.mml.cam.ac.uk/dtal/).

A team of Cambridge linguists has embarked on an ambitious project to identify how the languages of the world are built – from Inuit Yupik to sub-Saharan Bantu, from Navajo to Nepalese.

How languages are built

Parents are often amazed by the speed at which children acquire language in early childhood, becoming fluent around three years of age. Compare this with the average adult attempting to acquire a second language, and it's a quite remarkable achievement.

In the late 1950s, the American linguist Noam Chomsky suggested that children are born with an innate ability to acquire language – a 'blueprint', as it were, for speaking any language on the planet. According to Chomsky, encoded in the human brain is an innate set of linguistic principles he called the 'universal grammar' that encompasses all of the properties that any language can have. The language the child then actually speaks is simply determined by exposure to the language (or languages in the case of a multilingual family) they hear as they develop.

But precisely how a universal grammar might underlie the range of languages we have today, not to mention the many past languages that have vanished completely, is a continuing puzzle, as Cambridge linguist Professor Ian Roberts explained: "If you talk about a universal grammar then you might naturally think there is a universal language, when of course there isn't. Rather, there are thousands of different languages."

"The central notion is that the specification that the child has in the genome, the universal grammar, must be of the most abstract, general, structural properties of language and that different languages manifest these properties in slightly different ways," he added. "The empirical question then is to work out what it is about a language that guides the child's innate ability to acquire it. In other words, to understand how Chomsky's theory could work, we need to work out how languages are built."

Language footprints

One way to investigate the variation between languages is to suppose that there is in fact very little difference, and that each language can be deconstructed to a 'typological footprint' that defines it. This is the hypothesis that Professor Roberts and his team have now set out to investigate over the next five years, with €2.5 million funding from the European Research Council (ERC) Advanced Investigator Grant scheme.

"This starting premise is almost certainly going to prove too simplified," admitted Professor Roberts, "but in the process of homing in on precisely how languages are built, what we hope will emerge is a new perspective on comparative grammar for the languages of the world."

The idea that languages can be categorised into different types is not a new one but this project will break new ground in syntactic theory (the understanding of how sentences are constructed) by exploring how different languages measure up in terms of a set of five structural properties defined by the team.

Professor Roberts believes that a relatively small number of structural properties are needed to define each language's unique 'footprint' and that this footprint is crucial to learning the language, as he explained: "We think that while the innate universal grammar may determine certain gross features of language, it is encountering this footprint that fine-tunes the acquisition of language in children."

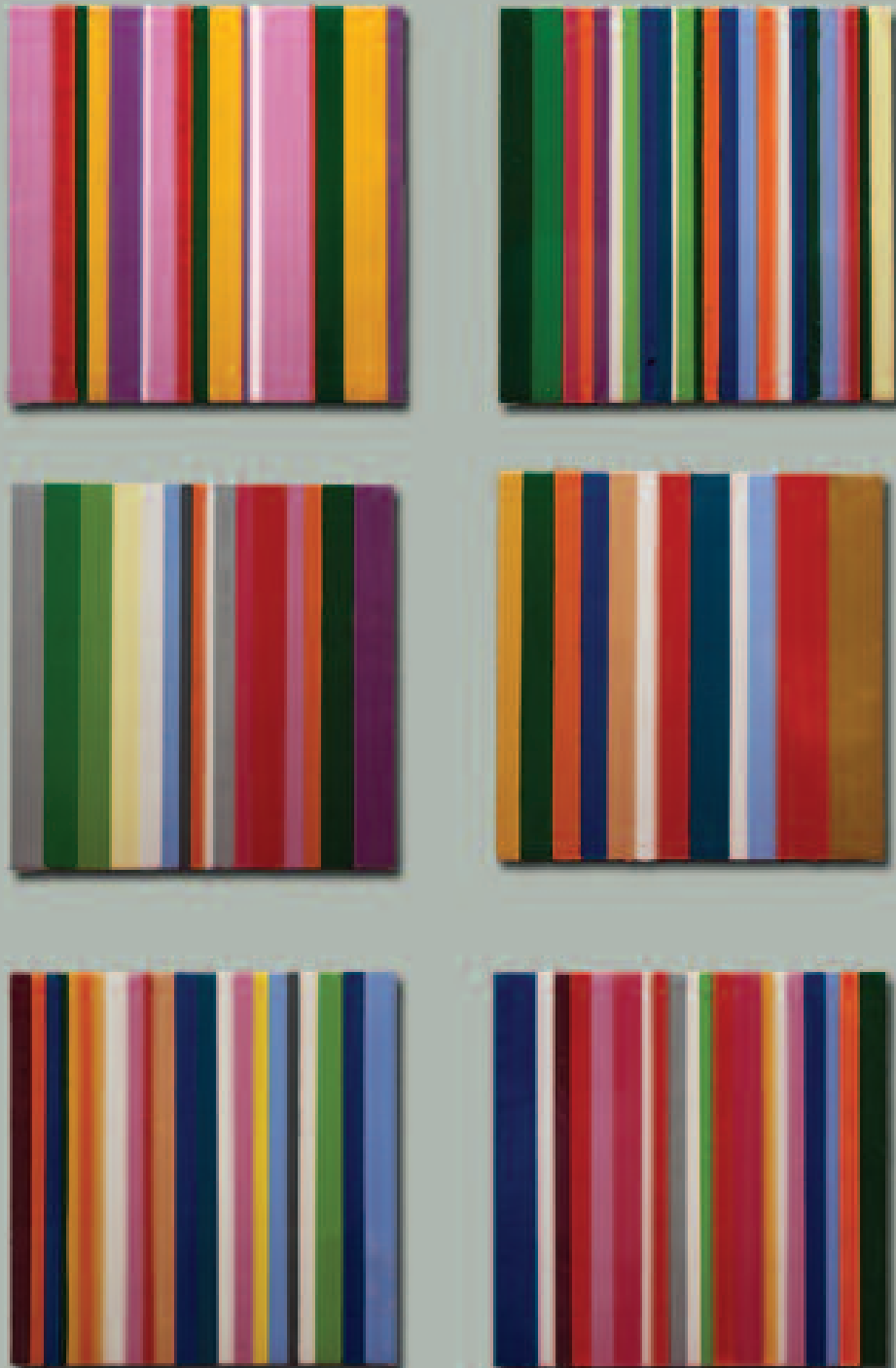
A linguistic duck-billed platypus

The carefully chosen properties under investigation relate to the more abstract, structural features of languages. "These properties are not always immediately apparent from surface data and require a bit



of analysis to discover," said Professor Roberts. "If children acquiring language can discover such complex properties spontaneously, this probably reflects their innate abilities since they are doing more than simply reproducing patterns."

One example is the order of words in a sentence. In English, for instance, the word order follows subject-verb-object (as in *John loves books*). Although this is one of the most common word orders in the world, it's by no means the only one. In fact, all of the logical permutations of subject, verb and object can be found in different languages but in very different frequencies, the most frequent being subject-object-verb (*John books loves*) in languages such as German and Japanese. In languages like Mohawk, words can even be combined to form new verbs (*John bookloves*).



Visual representation of 'rules-based' construction of language by artist Christian Faur

"We hope to reach a situation when we can make predictions about what types of languages are out there."

research being carried out by Professor Giuseppe Longobardi's group at the University of Trieste in Italy; Longobardi's group are looking at the variant features of languages that remain constant over long historical periods. In this way, they hope to be able to discern very ancient relationships among languages and language families, which in turn may tell us something about ancient population distributions and movements.

The main aim of the project though is to deepen our fundamental understanding of how languages vary and how the human mind works in acquiring language, explained Professor Roberts: "Our current view is that language is not pre-specified but rather under-specified in the sense that there are certain aspects about the structure of language that universal grammar doesn't say anything about. These gaps appear to be filled in as the child develops by cognitive mechanisms that work with the properties of the language they hear, and it is these properties that we aim to define."

Each language will have its own rules for this property, and for each of the other five properties being analysed; the task of the team is to identify these patterns. They will look at thousands of languages, from the languages of Europe to the Bantu dialects of the sub-Saharan, from Caribbean languages to the Carib languages of the indigenous Xingui peoples of Brazil, and from Navajo to Nepalese. Information will be garnered from online grammars, original historical documentation of language structures and, where feasible, native-speaker consultants.

"There are bound to be quirks and anomalies – the linguistic equivalents of the duck-billed platypus – a language that is just weird and doesn't quite fit into the big categories," said Professor Roberts. "But of course these isolated cases are interesting in themselves. We hope to reach a situation as

we refine the classificatory system when we can make predictions about what types of languages are out there."

Gap filling

Professor Roberts' hunch is that the classification will turn out to be more complicated than the team initially envisaged: "I suspect that we will need to evolve the properties as we go along until we arrive at the perfect set. That's what we are most interested in doing. It's the first time this has been done systematically or on this scale."

Tantalisingly, when the researchers arrive at a set of properties that categorise the structure of the languages of the world, the results will not only reveal relations among language families but could also tell us something about ancient patterns of human migration. Here, the project dovetails with



Professor Ian Roberts

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Music is more than just sound. Sharing many features with language, it has all the hallmarks of a communicative system, as Professor Ian Cross explains.

Music – or language in action?

In present-day Western cultures, we tend to underestimate the remarkable overlap between music and language in the functions they fulfil as communicative media. At first glance, music seems to us quite different from language; after all, we clearly cannot exchange information through music as we do through language.

But if we shift our cultural perspective, we find that in many traditional societies music is not just presentational but also participatory. People engage with each other in musical performance, making music together – what has been called *'musicking'*.

Among the research priorities of the Centre for Music and Science (CMS), established in 2003 in the Faculty of Music and staffed by Professor Ian Cross and Professor Sarah Hawkins (respectively, specialists in music and speech), is the relationship between music and language as closely interconnected systems of communication. Ongoing research, such as that of graduate student Sarah Knight, is demonstrating how participatory music shares many functional attributes with aspects of speech – language in action.

All in the timing

Conversation is not just about information exchange, it's about continually establishing and reaffirming the mutual recognition of each other as social beings. This relational dimension in speech involves tone of voice or prosody – not dissimilar from melody in music – as well as timing.

Timing in conversational interactions is extremely important to enable us to produce signals (gestures, interjections) at appropriate points and to take turns to speak. Timing in speech makes it clear that we understand the information that we are receiving, creates and sustains a sense of rapport with other speakers, and directs another's attention to what is being said.



Music, like language, fulfils key functions in human communication

There's now a substantial amount of evidence from research at CMS and across the field of psychology that regularity or periodicity of timing – a regular beat – also has these last two functions. If people move together to a beat, then they are more likely to experience each other as sympathetic; if we hear a beat, even subconsciously, it will capture our attention.

Feel the rhythm

Sarah Knight has applied these ideas to understanding aspects of timing in language. Although speech lacks the overt rhythm of music, speakers might modulate how they deliver speech to capture listeners' attention. To understand how rhythmicity is used in speech, Sarah analysed examples of everyday conversation, university lectures, political speeches and highly rhythmic poetry, measuring how listeners rated the rhythmicity of each.

Everyday conversation, she finds, has no regular pulse; to a lesser extent, didactic lectures also lack rhythm, probably as a result of being constrained by the forms of the specific information that we wish to impart.

In party political oratory, however, she finds the very opposite is likely to hold. Rhythm is used deliberately and consistently, even to the extent that the actual information is often the least significant component of the talk. The implication is that rhythmicity is used in an attempt to manipulate the attentiveness of listeners, and also signals how much speakers 'want to be liked'.

Part of the human toolkit

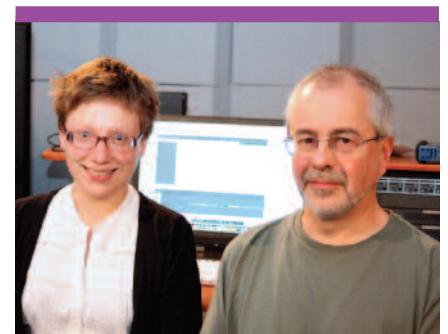
Other research at CMS is also reinforcing the idea that speech and music are closely connected, and may have common evolutionary origins.

The early appearance of music in our archaeological record lends weight to the

idea that the capacity for music is an adaptive characteristic of the human species. Music might have played a role in enabling our ancestors to get on with each other – to form, maintain and re-form stable yet flexible groups or cultures – in effect, an evolutionary scenario that would have been important for survival.

In fact, music and speech are best conceived of as having co-evolved as components of a generalised human communicative toolkit. Music provides a relational medium similar to the relational dimension of speech, but different enough to be an important component of the human repertoire of communicative interactions in its own right, and far better suited than speech for the management of situations of social uncertainty.

If this is the case, then music may be – and may have been – as important as language in enabling humans to achieve the unique flexibility in social interaction that characterises the human species.



Sarah Knight and Professor Ian Cross

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English language testing, and the research that underpins it, has been elevated to a new level by the increasing global dominance of English, now used by an estimated 1.8 billion people worldwide.

Testing the world's English

Language testing affects the lives of millions of people every year. The Cambridge English qualifications, produced by the University of Cambridge ESOL Examinations and taken by more than 3.3 million people worldwide annually, are a passport to countless opportunities. A successful test result could open the door to jobs, further education and even countries.

But Cambridge ESOL is much more than exams. Behind these gold standard tests is an organisation (part of the University department Cambridge Assessment) that is deeply committed to research into language teaching and learning. Cambridge ESOL's team of specialists not only deliver tests that are fair, accurate and valid but their work is also contributing to global educational reforms. And with the biggest ever study of the language proficiency of European school children now under way, their research promises to shine new light on the way language is taught across Europe.

Fit for purpose

For almost 100 years, ever since the first Certificate of Proficiency in English test rolled off the presses in 1913, Cambridge has been associated with English language testing. Now with a portfolio of over 20 different exams, Cambridge ESOL prides itself on being able to provide the right assessment for the right person. 'Cambridge English', a branding developed by Cambridge ESOL and Cambridge University Press, is synonymous with good practice in English language learning, teaching and assessment.

"Language assessment has evolved to keep pace with the way in which English is being used around the world," said Cambridge ESOL's Chief Executive, Dr Mike Milanovic. "But this process has accelerated over the past 20 years with the growing recognition by governments that English is a basic skill essential for the future



Every year, over 3 million people in 130 countries take a Cambridge English exam

employability of their citizens. English is now a core part of school curricula, no longer regarded as a foreign language."

With this comes a great responsibility for assessment providers to develop reliable tests that meet the needs of teachers and learners, and are relevant to evolving educational curricula. This is where research becomes especially important.

Cambridge ESOL's 40-strong team is the largest dedicated research capability of any provider of English language assessment. Each year, its researchers interrogate hundreds of millions of pieces of information relating to the tests taken by over 3 million candidates. It's a vast, complex exercise that combines data from pre-tests and tests, candidates' demographics and information on the impact that tests have on life-changing decisions such as immigration, education and employment. Only then can a picture emerge of how fit for purpose the exams are and how they can be continually improved.

Global impact

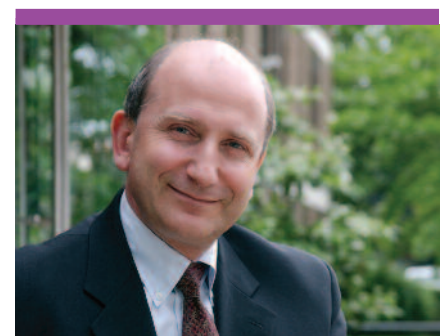
Cambridge ESOL's research also looks beyond its exams to global curricula development and educational reforms. English Profile, for instance, is a ground-breaking programme it leads with Cambridge University Press that is shaping the future of English language learning, teaching and assessment worldwide. The aim of the network of global specialists, which includes researchers at Cambridge's Department of Theoretical and Applied Linguistics, is to develop a definitive description of English – its grammar, vocabulary and functional language – and to relate this to the language that learners can be expected to demonstrate at each level of the Common European Framework of Reference for Languages.

Meanwhile, results from the largest and most comprehensive survey ever to assess

how well European pupils know other languages are being finalised ready for reporting to the European Commission (EC) in early 2012. SurveyLang, which is being conducted by a consortium led by Cambridge ESOL, is measuring the language competence of 50,000 pupils aged 16–18 years across 15 countries in Europe for two out of five European languages.

Once the survey is completed, policy makers will have access for the first time to evidence on a European scale that links foreign language competence and insights into good practice in language learning. Not only will the information be useful to the EC for understanding the nature of foreign language learning in schools, but it will also help individual governments make important policy decisions around the way language is taught in their own country.

"What we're striving for through these and other research projects," added Dr Milanovic, "is to make sure that what we do really does have a positive impact on the learning, teaching and assessment of English in the real world."



Dr Mike Milanovic

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Norman languages spoken in the Channel Islands for a thousand years are now severely endangered. Linguist Dr Mari Jones has been analysing the languages and tracing why they have declined.

Island language in a sea of change

It may come as some surprise that Norman is spoken in the British Isles today. In the British parliament, the use of certain Norman phrases, for example during the passage of Bills between the House of Commons and the House of Lords, is a tradition that dates back to a time just after the Norman Conquest, when Norman French was the official language of government.

But on the Channel Islands of Jersey, Guernsey and Sark, Norman is a native language, albeit now endangered. In fact, Norman has been spoken in the Islands for a thousand years and, despite the fact that the archipelago has been united politically with Great Britain since 1204, until relatively recently most of the inhabitants were Francophone.

The presence of English was probably first felt to any significant extent when, in the Middle Ages, military garrisons were established on the Islands to defend them against the French. But Norman French remained the everyday speech for most Islanders until well into the 19th century, when growing trade and transport links led to ever-increasing contact with the British mainland and hence to progressive Anglicisation.

Dr Mari Jones, from the Department of French, has worked extensively in the Channel Islands, painstakingly analysing and documenting the dialects and examining the linguistic consequences of the contact that has taken place between English and the (three distinct) Norman French dialects of the Channel Islands (called locally Jèrriais, Guernésiais and Sercquais).

Her research takes place against a backdrop of dwindling numbers of native speakers, many of whom she has interviewed and recorded. "This is work that simply cannot wait until a metaphorical tomorrow," she explained. "On Sark, for instance, speakers of Sercquais – the most

vulnerable variety of Norman French and the least studied – probably number no more than 20 in a population of 600. Sadly, it may not be too long before the tongue shares the same fate as Auregnais, the Norman dialect of the island of Alderney that died out in the mid-20th century. Analysis of the languages of the Channel Islands is therefore essential while they are still alive." Dr Jones's recordings feature, in all likelihood, people who will be the last ever native speakers of these dialects.

Language loss

Languages become threatened for a variety of reasons – there might, for instance, be political, religious or cultural forces at play. "But for many endangered languages," said Dr Jones, "the reason they are vanishing is because people don't want to speak them any more. In a nutshell, they perceive the native language as outdated and the new language as the language of progress."

A changing view of the world around them has, Dr Jones believes, had an impact on speakers' motivations to speak Channel Island French. Events in the 20th century, such as the growth of tourism and the offshore finance industry, led to English being seen as a means to prosperity and social advancement, and also brought in their wake large-scale immigration to Jersey and Guernsey from the British mainland.

Moreover, before this, the evacuation of a significant number of the women and children from Guernsey, Jersey and Alderney in the days preceding the German occupation of the Channel Islands during the Second World War also had severe linguistic repercussions, as Dr Jones explained: "A considerable proportion of the child population of each island spent the next five years, until 1945, cut off from their native tongue and immersed in the very language with which it was in competition.



On their return, many had either forgotten their Channel Island Norman French or chose to continue using English."

Jèrriais is now spoken by just 2,874 (3.2%) of the Jersey population and Guernésiais by 1,327 (2.2%) of the Guernsey population, according to censuses carried out in the Islands in 2001. However, as Dr Jones pointed out, conscious steps are now being taken to safeguard the future of Channel Island Norman French: "What was once seen as a negative link between language and identity is nowadays regarded as a positive one and, on Jersey and Guernsey, the language is currently being taught in schools." Revitalisation efforts are focused by the 'Office du Jèrriais' on Jersey, where language planning has made the most headway in the archipelago.

Language contact

One element of Dr Jones's research is aimed at understanding what happens when languages are in contact. In Jersey, for instance, bilingualism has been widespread since at least the mid-20th century and so-called contact phenomena abound: in the course of a conversation, speakers may alternate between one language variety and another (called code-switching) or transfer syntactic patterns such as word order from one language to another.

During several field trips to the Channel Islands, Dr Jones has interviewed and recorded speakers to examine precise



PHILIP DE JERSEY/WWW.GUERNSEYPOSTCARDS.ORG.UK

Anglicisation of the language of the Channel Islands took hold in the 19th century, when trade links with England led to improved communication by postal service and boat, and ever-increasing contact with the English

instances where language change occurs. She has also conducted a detailed study of a remarkable corpus of 19th-century translations into Guernésiais that include the Bible and Shakespeare's plays from which she has been able to gain insight into hitherto undocumented grammatical features of this dialect. Her work thus provides important clues as to how languages develop over time and the effects of contact with more dominant tongues.

"The presence of contact phenomena on the Channel Islands came as no surprise. Social conditions mean that no variety of insular Norman is used any longer by any speaker as their sole means of communication," she said. "However, at the same time, we should be careful not to make assumptions about what we are likely to find. Just because a 'big' language is in contact with a 'small' one we should not take it for granted that the influence will all be one-way or that the speech of all members of a given community will be influenced in the same way. For example, and quite surprisingly, a significant number of Jèrriais speakers did not code-switch at all. It is possible that this desire to keep their language free of English words may be in some way linked to their positive attitude towards Jèrriais: they may be bilingual but they did not feel they had a dual identity."

The Duchy's legacy

Dr Jones's newest research will take her to mainland France, to study the continental speakers of Norman. "Since the loss of the Duchy of Normandy in 1204, the Norman territory has been fragmented," she explained. "Although the split was initially political, rather than linguistic, the fact that the Channel Islands have been governed by Britain, and continental Normandy by France, has meant that these territories have found themselves on different sides of an ever-widening linguistic gulf as English and French, respectively, become dominant in daily life."

Linguistically, insular and continental Norman have never been further apart than today. Dr Jones's project will investigate whether their contact with different standard languages (English and French) is leading to these varieties of Norman evolving via different linguistic mechanisms.

The impending extinction of Norman makes it vital that this comparison is undertaken while native speakers still exist – a linguistic situation that has parallels all over the world. As the UNESCO Atlas of the World's Languages in Danger makes only too clear, 230 languages reached extinction in the past 60 years, and some 3,000 languages are currently endangered.

Cambridge Group for Endangered Languages and Cultures (CELC)

The varieties of Channel Island Norman French are among 6,000 languages spoken worldwide today as estimated by UNESCO. But this linguistic wealth – the cultural equivalent to biodiversity – is under threat as languages become endangered and die out.

CELC has brought together researchers from across the University, united by their common interest in endangered languages. Some of the researchers study endangered languages because of what they can tell us about the cultural history and identity of a people; others examine the nuts and bolts of how language changes and the insight this provides on how languages are 'built'; yet others are concerned with understanding, preserving and documenting dying languages before they are lost for ever.

"There is no one size that fits all with languages," explained Dr Mari Jones, who is a founder member of CELC, "That's why the different perspectives on language that CELC brings together are so stimulating."

With funding from the Centre for Research in the Arts, Social Sciences and Humanities (CRASSH) for 2011–12, CELC continues its series of workshops and seminars. These events have brought internationally renowned speakers to Cambridge to raise awareness of the threats facing linguistic and cultural diversity.

For more information, please visit <http://groups.pwf.cam.ac.uk/celc/>

"This is work that simply cannot wait until a metaphorical tomorrow."



Dr Mari Jones

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Ancient manuscripts that hold important clues to India's intellectual and religious traditions will be the focus of a new study.

Powerful words



This palm leaf manuscript in the University Library's South Asian collection is the oldest dated and illustrated Sanskrit manuscript known worldwide (997 AD); MS Add.1464, 127v, left panel

In a world that seems increasingly small, every artefact documenting the history of ancient civilisations has become part of a global heritage to be carefully preserved and studied. Among such artefacts, manuscripts occupy a distinctive place – they speak to us with the actual words of long-gone men and women, bringing their beliefs, ideas and sensibilities to life.

In this respect, the collections of South Asian manuscripts in the Cambridge University Library are a precious resource. Written on now-fragile birch bark, palm leaf and paper, the 2,000 manuscripts in the collection express centuries-old South Asian thinking on religion, philosophy, astronomy, grammar, law and poetry. An early catalogue of part of the collection in 1883 found among its treasures a 10th-century Buddhist Sanskrit manuscript from India – the oldest dated and illustrated Sanskrit manuscript known worldwide.

Now a major exercise in 'linguistic archaeology' has set out to complete a comprehensive survey of the full collection, a substantial academic challenge that is being funded by the Arts and Humanities Research Council. Led by Dr Vincenzo Vergiani with Dr Eivind Kahrs, both specialists in Sanskrit, the project will study and catalogue each of the manuscripts, placing them in their broader historical context. Most of the holdings will also be digitised by the Library.

"One reason this collection is so important is because of the age of many of the manuscripts," explained Dr Vergiani. "In the heat and humidity of India, materials deteriorate quickly and manuscripts needed to be copied again and again. As a result, many of the early Indian texts no longer exist."

In fact, some of the oldest holdings of the Library's South Asian collection were discovered not in India but in Nepal, where the climate is more temperate. In the 1870s,

Dr Daniel Wright, surgeon of the British Residency in Kathmandu, rescued the now-priceless cultural and historical artefacts from a disused temple, where they had survived largely by chance.

Perfect language

More than half of the collection is in Sanskrit, a language that has dominated the literary culture of pre-modern South Asia for almost three millennia. Its earliest attestations are found in the Vedic hymns (texts that are still central to Hinduism), dating from the end of the second millennium BC.

"The word Sanskrit means refined or perfected. From a very early stage, its speakers were obsessed with handing down their sacred texts intact," said Dr Vergiani. "Out of this developed an attention to how the language works. A grammatical tradition arose that produced, around the 4th century BC, the work of Pāṇini, an amazing intellectual achievement and arguably the beginning of linguistics worldwide, which made the language constant, stable and transmissible."

It is this robustness that Dr Vergiani believes explains how the language became so prevalent across South Asia – a situation that has been likened to the spread of Latin across Europe: "It was used by religious figures and royalty, scholars and scientists, administrators and artists. Well into modern times, Sanskrit culture was very much alive throughout India, and the language is still used by a number of intellectuals and religious figures today."

Opening up scholarship

The widespread use of Sanskrit as the language of power and communication across South Asia makes the collection at the Library so significant. The manuscripts, written in centuries that spanned momentous political and economic change, are an invaluable and

untapped source for understanding the pre-colonial past of South Asia, and therefore its present.

By combining traditional philological methods with advanced information technology, the project will make these extraordinary documents available in new ways, helping to further research on the intellectual traditions, religious cults, literature and political ideas of South Asia. The corpus of information will be made available through the Library's new online digital library (<http://cudl.lib.cam.ac.uk/>).

Tantalisingly, there are many works in Indian literary history that today are known only in name. "The hope has always been that one day these missing works will be found," said Dr Vergiani. "Perhaps some will reappear in this collection."



Dr Vincenzo Vergiani

For more information, please contact Dr Vincenzo Vergiani (vv234@cam.ac.uk) at the Faculty of Asian and Middle Eastern Studies (www.ames.cam.ac.uk/).

Mother tongue, prehistoric father

A new analysis suggests that language change among our prehistoric ancestors came about through the arrival of immigrant men – rather than women – into new settlements.



Modern-day Melanesian tribe; in prehistory, some Melanesian tribes switched to speaking Polynesian when the immigrant Polynesian male component of the population reached about 10–20%

Spoken language leaves no fossils. So, determining how language developed in early prehistory, long before the development of writing around 5,000 years ago, is a challenging task.

Many of the languages of the world can be grouped into language families. A language such as English, in the Indo-European language family, along with most of the languages of Europe, Iran and India, developed from Proto-Indo-European, brought to Europe by our migrating ancestors. Individual languages will have emerged from these shared beginnings, becoming more diverse and changing following contact with other languages over many thousands of years. But where those migrant ancestors came from remains a disputed question.

In the absence of written artefacts, tracing language change is more challenging than tracing a sequence of ancient colonisations. In recent years, scholars have turned their attention to whether genetic markers could provide the key. Several genetic studies worldwide have looked for correlations between the presence of certain genetic markers in communities with the language its members speak.

Now, out of a reassessment of the published data by geneticist Dr Peter Forster and archaeologist Professor Colin Renfrew has emerged a global picture – one that suggests that mother tongue is spread by prehistoric fathers.

The Y of language change

The new analysis, published in September 2011 in *Science* magazine, studied the instances of genetic markers [specifically the male Y chromosome and female mitochondrial (mt)DNA] from several thousand individuals in communities around the world.

From Scandinavian Vikings who ferried kidnapped British women to Iceland, to

African, Indian and Polynesian tribes, a pattern has emerged which appears to show that the arrival of men to already populated locations – as a result, for example, of agricultural dispersal or the arrival of military forces – can have a significant impact upon the language that is spoken.

Perhaps the most striking instance of sex-biased language change comes from a genetic study carried out by researchers in the Netherlands in 2008 on the prehistoric encounter of expanding Polynesians with resident Melanesians in New Guinea and the neighbouring Admiralty Islands. The New Guinean coast contains pockets of Polynesian-speaking areas separated by Melanesian areas. The Polynesian mtDNA level (the female-specific marker) is similar in these areas regardless of language, whereas the male Y chromosome correlates strongly with the presence of Polynesian languages.

“It may be that during colonisation episodes by emigrating agriculturalists, men generally outnumber women in the pioneering groups and take wives from the local community,” explained Professor Renfrew, from the McDonald Institute for Archaeological Research. “When the parents have different linguistic backgrounds, it may often be the language of the father which is dominant within the family group.”

Past studies have shown similar findings in the Indian subcontinent among the speakers of Tibeto-Burman and among the immigrant Indo-European languages as opposed to indigenous Dravidian languages. In the Americas, too, language replacement in the course of postulated farming dispersal has also been found to correlate for the Uto-Aztecan language family.

Dr Forster, of Murray Edwards College, also pointed to the fact that men have a greater variance in offspring than women – they are more likely to father children with different

mothers than vice versa. This has been recorded both in prehistoric tribes such as the 19th- and 20th-century Polar Eskimos from Greenland and in historic figures like Genghis Khan, who is believed to have fathered hundreds of children. Indeed, his Y chromosome is carried by 0.5% of the world’s male population today.

“Prehistoric women may have more readily adopted the language of immigrant males, particularly if these newcomers brought with them military prowess or a perceived higher status associated with farming or metalworking,” added Dr Forster. “Whether in European, Indian, Chinese or other languages, the expression ‘mother tongue’ and its concept is firmly embedded in popular imagination – perhaps this is the reason why for so many years the role of fathers or, more likely, specific groups of successful males, in determining prehistoric language switches has not been recognised by geneticists.”



Professor Colin Renfrew (left) and Dr Peter Forster

For more information, please contact Dr Peter Forster (pf223@cam.ac.uk) at Murray Edwards College or Professor Colin Renfrew at the McDonald Institute for Archaeological Research.

Past versus present in an age of progress: the Victorians

As a £1.2 million project on Victorian Britain reaches the end of its five-year programme, Professor Simon Goldhill reflects on how interdisciplinary research has to be the answer when it comes to understanding the Victorians.



The Victorians had a penchant for exhibiting live human beings, especially those from exotic foreign climes; Dr Sadiya Qureshi's new book explores how foreigners were displayed for the amusement and education of 19th-century Londoners

DR SADIYA QURESHI, FROM ILLUSTRATED LONDON NEWS, SEPTEMBER 6, 1845, P. 160

It was the age of industrialisation and political revolution, compulsory education and the dominance of the novel, the start of the postal service and the invention of the train, the excitement of evangelical Christianity and the critical challenge to the authorities of the past. Above all, it was an era that knew it was a time like no other, a time of radical progress and visionary reform. As the Victorians were forging remarkable economic and technological innovations, they were also obsessed with understanding their own history. In archaeology, geology, history, theology and evolutionary biology, how the past was understood was revolutionising the present – and shaping the future in which we now live.

For the past five years, a project funded by the Leverhulme Trust has taken a fresh look at the development and impact of the competing views of the past in 19th-century Britain. 'Past versus Present: Abandoning the Past in an Age of Progress', a project carried out by the Cambridge Victorian Studies Group, has broken new ground in transcending the disciplinary boundaries that are themselves an intellectual legacy of the Victorians.

It has proved to be a wonderful experience for all concerned, and a model of how productive and exciting a long-term interdisciplinary project can be. Each member of the project has found their work

developing and expanding its horizons, and the group has provided a remarkably supportive space for exploring the richness of Victorian culture. Historians of modern Britain (Professor Peter Mandler) have been brought together with historians of science (Professor Jim Secord), and classicists (Professors Mary Beard and Simon Goldhill) with experts in literary criticism (Professor Clare Pettitt), along with eight postdoctoral fellows and three graduate students, to explore the full range of the Victorian experience, representation and comprehension of the past.

Central to the group's activities was the weekly meeting where we read and discussed Victorian material, secondary sources and our own research in progress. These were generous but heated debates, where each member had something different to bring to the table. The varied ranges of knowledge and approaches were thrashed out, sometimes painfully. These led to regular workshops with invited guests from around the world, which in turn produced editions of journals and other publications (see panel for the two most recent books).

Our projects looked at major defining questions of Victorian culture that can be properly treated only by a multidisciplinary team: from what the Victorians learned in school and university, to the poetry or novels they wrote; from how the new

Victorian appetites

A fascination for imported Zulus and the living curiosities of the modern world, an obsession with the beauty and perfection of ancient Greece and Rome – two very different sides of Victorian appetites, and the subject of recently published books by members of the Cambridge Victorian Studies Group.

In 1853, 13 Zulus were brought and displayed as “the savages at Hyde Park Corner” (where Dickens saw them), to perform dances, rituals and songs for a public of gazing English men and women. At first, such shows tended to be small-scale entrepreneurial speculations of just a single person or a small group. By the end of the century, performers were being imported by the hundreds and housed in purpose-built “native” villages for months at a time, delighting the crowds and allowing scientists and journalists the opportunity to reflect on racial differences, foreign policy, slavery, missionary work and the empire.

In the recently published *Peoples on Parade: Exhibitions, Empire, and Anthropology in Nineteenth-Century Britain*, Dr Sadiya Qureshi provides the first substantial overview of the Victorian penchant for exhibiting live human beings, especially those from exotic foreign climes.

The book is full of startling stories and stunning images, but what makes it so interesting and important is its revelation of how science and popular culture developed hand in hand where race, anthropology and geography are concerned. We are still inheriting the impact of the Victorian fascination with race, and this book reveals that history with vibrant and incisive insight.

If Dr Sadiya Qureshi explores how the Victorians looked at the exotic, disturbing and denigrated ‘others’ of Victorian thinking – the natives, the savages, the racially inferior – Professor Simon Goldhill looks at the Victorians’ projection of an ideal, glorious origin for Western culture in classical antiquity. Just as the Victorians stared with horrified distance at “the savages”, so they wondered at the perfection of Greek bodies, the order of the Roman Empire, the beauty and profundity of classical poetry.

Victorian Culture and Classical Antiquity: Art, Opera, Fiction, and the Proclamation of Modernity demonstrates how classics made up the furniture of the mind for Victorians, educated, as they were, in Greek and Latin and surrounded by classical imagery.

But, more significantly, this book also shows how classics became the way of enacting the most pressing cultural anxieties of the period. Whether it was Oscar Wilde and his chums looking back to Greece for sexual liberation, or painters turning to classical nudity to ground their aesthetic vision, or historians and novelists arguing the politics of democracy or the role of the early church, it was always a detour through the ideal of classical antiquity that framed their thinking.

The Victorians prided themselves, anxiously, on being an age of progress, but progress was often judged and understood according to the ideal model of the ancient past – the Greece, as Nietzsche paradigmatically put it, which is the only place where we are truly at home.

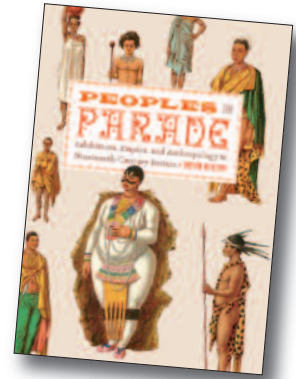
These newly published books show how complex a business Victorian self-definition and self-understanding is: between public shows and grand opera, anthropology and history, religion and novels, science and painting, an image of what Western culture is, and should be, was being forged – and we are all still the heirs of this work of historical self-consciousness. Both books are the product of many years of research – and both have been fundamentally affected by their gestation within the interdisciplinary milieu of the Cambridge Victorian Studies Group.

technologies of archaeology transformed biblical scholarship, to how imperial administrators changed policies from conquering and looting to ruling and maintenance of national cultural heritage; and from explorations of contemporary political violence to explorations of the influence of the ancient world on contemporary political idealism.

The project has left a mark in the field of Victorian studies. It has raised the profile of hitherto neglected bodies of knowledge which the Victorians took for granted but which we do not, largely because of our different disciplinary map. We have gained a new appreciation of the paramount significance for the Victorian imagination of

classical languages and archaeology, of Egypt and the Far East, of geology and the Biblical texts.

Although the project inevitably calls itself by the buzzword ‘interdisciplinary’, we were actually studying a period when the disciplines were just beginning to be formed and professionalised. In effect, much of the work was not so much interdisciplinary, as learning to reach back behind the disciplines to different regimes and organisations of knowledge. In exploring the Victorian attitudes to the past, we were exploring how the current scholarly map was formed. In investigating a Victorian sense of heritage, we were discovering the intellectual heritage that all modern academics share.



Peoples on Parade: Exhibitions, Empire, and Anthropology in Nineteenth-Century Britain (2011) by Dr Sadiya Qureshi is published by University of Chicago Press



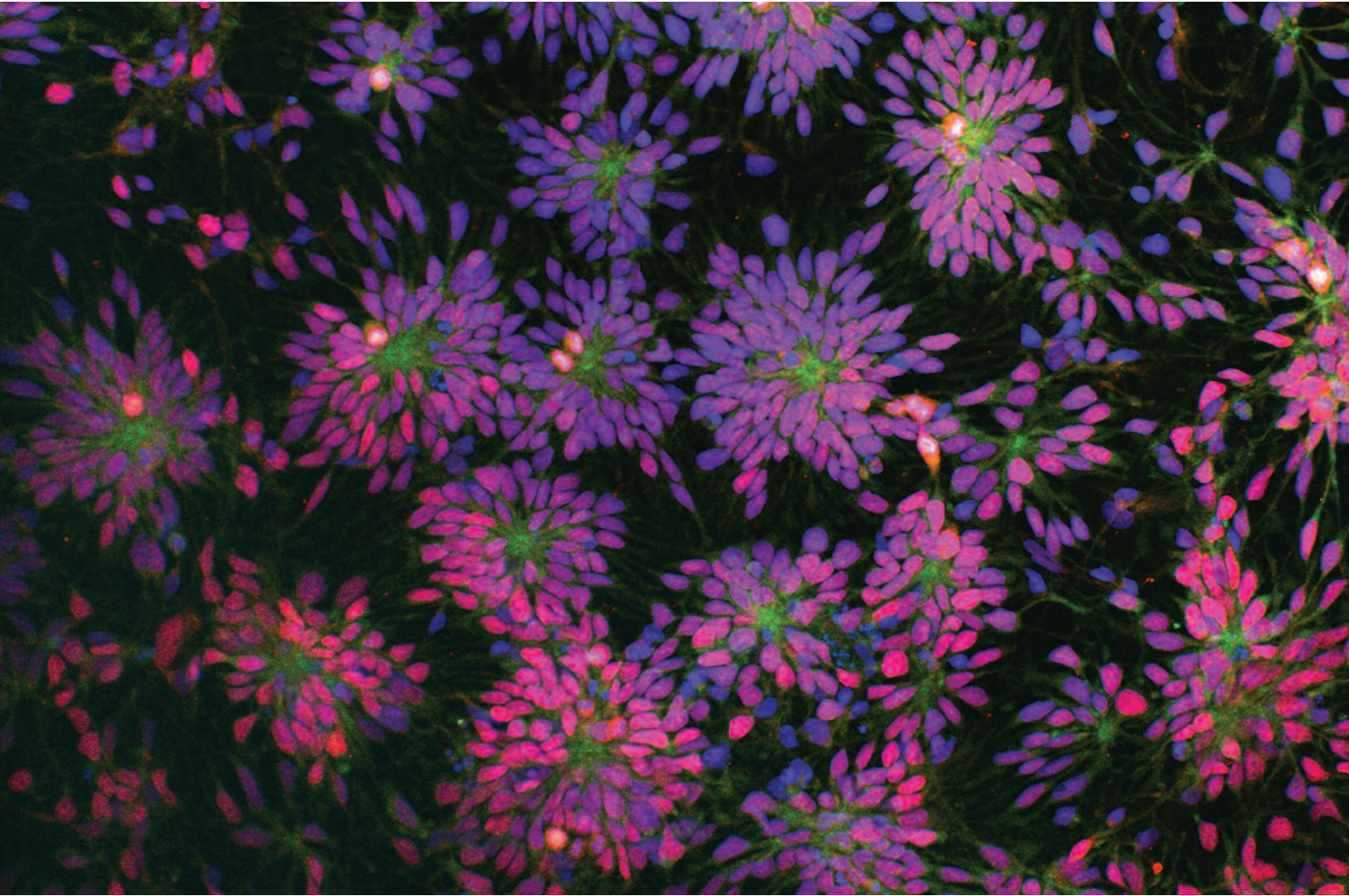
Victorian Culture and Classical Antiquity: Art, Opera, Fiction, and the Proclamation of Modernity (2011) by Professor Simon Goldhill is published by Princeton University Press

“The project has left a mark in the field of Victorian studies. It has raised the profile of hitherto neglected bodies of knowledge which the Victorians took for granted but which we do not.”



Professor Simon Goldhill

For more information, please contact Professor Simon Goldhill (sdg1001@cam.ac.uk), who is at the Faculty of Classics and is Director of the Centre for Research in the Arts, Social Sciences and Humanities (CRASSH; www.crassh.cam.ac.uk/), or visit www.victorians.group.cam.ac.uk/



Rosettes of human, patient-specific neural stem cells generated from induced pluripotent stem cells

Cambridge stem cells united

Cohesion, collaboration and clinical impact are the watchwords of a new phase of stem cell research in Cambridge.

Few areas of research have been surrounded by such hope – and such hype – as stem cell biology. With their unique capacity to renew themselves and to give rise to the body’s many different cell types, stem cells have the potential to repair tissues damaged by disease or trauma: from a failing heart to lost nerve cells.

But the route from the laboratory to the clinic is a long one. Before patients can be treated, many years of fundamental research and clinical testing have to take place. “Rushing into the clinic without basic understanding may create some headlines but no real benefit for patients,” said Professor Austin Smith, Director of Cambridge’s Wellcome Trust (WT) Centre for Stem Cell Research. “Cambridge is one of the few places in the world that has a critical mass in both basic stem cell science and medical translation.”

Since 2007, the University has invested over £38 million in laboratories and posts, and has prioritised stem cell biology as a Strategic Research Initiative. There are now 26 stem cell laboratories across the University, which have attracted some £95 million in funding. Many of the researchers are hosted by the WT Centre and the University’s Medical Research Council

(MRC) Laboratory for Regenerative Medicine (established by Professor Roger Pedersen), which focus on fundamental and translational stem cell research, respectively.

Now, a major effort is under way to draw together stem cell research across the University into a new Stem Cell Institute (SCI). The SCI currently spans several sites but the intention is to bring all these groups together ultimately in a major new research institute on the Cambridge Biomedical Campus. Unification will create the ideal stage for the translation of fundamental research into clinical benefits – research such as the long-running programme led by Professor Robin Franklin in the Department of Veterinary Medicine, whose work on multiple sclerosis is about to move into clinical trials (see panel).

“Collaboration has always happened in Cambridge,” explained Professor Smith, “but pulling people together will capitalise fully on the rich opportunities. SCI will provide a unified organisation and a strategic direction for stem cell research that starts from basic science but sets clinical delivery and interaction with bioindustry firmly in its sights.” A key component will be interdisciplinary research teams that link stem cell biology with molecular disease mechanisms through to clinical applications.

Alongside Professor Smith in spearheading the reshaping will be the newly established Chair of Stem Cell Medicine, to which Professor Oliver Brüstle has been elected. Professor Brüstle is currently Director of the Institute of Reconstructive Neurobiology at the University of Bonn, Germany, and an expert in stem cells of the nervous system and their application in neurodegenerative disease.

Professor Brüstle – who notably fought for legalisation of research on human embryonic stem (ES) cells in Germany and finally became the first scientist to obtain a respective license – regards stem cell therapies as “just another way to treat disease”. He is at pains to emphasise that cell transplantation is not the only way that stem cells can bring clinical benefit: “In fact, a much closer prospect is the use of stem cells to study specific diseases in the laboratory and to develop new drugs.” Another important opportunity is the possibility of improving cancer treatment by identifying and targeting tumour stem cells.

“Of course there are challenges to overcome before stem-cell-based medicine is commonplace,” added Professor Brüstle. “For example, we need to learn more about how human ES cells differ from mouse ES cells, and how their fate is controlled.”

In fact, a major discovery about the differences between human and mouse ES cells was made in Cambridge. Professor Pedersen and Dr Ludovic Vallier and colleagues showed that human ES cells represent a developmentally more mature stage than naive mouse ES cells. This can explain why some procedures for producing specific cell types from mouse ES cells do not work well with human cells. “Human ES cells are less versatile. This research has changed the way stem cell researchers think about human ES cells,” explained Professor Smith.

The goal now is to understand this difference at a molecular level. Professor Azim Surani at the WT/Cancer Research UK Gurdon Institute in Cambridge has pioneered a deep-sequencing technique to do precisely this. His team can now analyse the entire transcriptome (all the gene products) in a single stem cell, opening the door not only to understanding the specific nature of human ES cells but perhaps also to how to make them more like mouse cells.

Professor Smith foresees a time when stem cells will permeate all areas of biology: “Stem cells are going to be instrumental in taking us to the next level of understanding about how cells make decisions about their fate. Increasingly, we’ll see them being used in laboratories as systems to look at basic biological questions that may have nothing directly to do with stem cell biology. Stem cells will soon become the research tool of choice in mammalian cell biology.”

Self-service brain repair in multiple sclerosis (MS)

A new clinical trial hopes to restore the functions lost in MS by boosting the activity of stem cells in the patient’s brain.

Researchers led by Professor Robin Franklin at the MS Society Cambridge Centre for Myelin Repair recently discovered a molecule that is capable of activating the brain’s own stem cells to repair damage caused by MS. Preparations have begun for a small-scale trial to test whether this process can regenerate lost nerve function, for which there is currently no treatment available.

Nerve fibres are progressively damaged in MS because they lose a protective coating of myelin when the cells that make it (the oligodendrocytes) are destroyed by the body’s immune system. The new treatment will stimulate stem cells that occur naturally in the brain and which have the ability to regenerate lost oligodendrocytes.

In the course of over two decades of research, Professor Franklin and colleagues have found that one of the major problems in MS is that the patient’s stem cells lose the ability to become normal oligodendrocytes. When oligodendrocytes are destroyed during the MS disease process, they are not replenished from the brain’s pool of stem cells. But the ability can be regained when the patient’s stem cells are activated through the retinoid acid receptor RXR- γ , as shown in collaboration with colleagues in Edinburgh using animal models and published in *Nature Neuroscience* in January 2011.

The discovery was a landmark moment in the search for treatments for MS, as Professor Franklin explained: “If we can encourage the patient’s own stem cells to develop into oligodendrocytes and replace the lost myelin, then this might restore the nerve functions lost in MS.”

In fact, the proposed treatment revolves around two elements: not only repairing the damage but also arresting any further damage caused by the patient’s immune system. An effective treatment for halting the destruction of oligodendrocytes using alemtuzumab (Campath) was developed in Cambridge by Professor Alastair Compston and Dr Alasdair Coles at the Department of Clinical Neuroscience.

The new trial, which is currently being designed by Dr Coles together with colleagues at University College London and the University of Edinburgh, and is not yet recruiting patients, will use a licensed drug, bexarotene, which activates RXR- γ .

Professor Franklin added: “Essentially, the philosophy of our approach is not to transplant stem cells from elsewhere but to encourage the patient’s own stem cells to do the work of repairing the damaged tissue.”

For more information, please contact Professor Robin Franklin (rjf1000@cam.ac.uk) at the MS Society Cambridge Centre for Myelin Repair.

Unification will create the ideal stage for the translation of fundamental research into clinical benefits.



Professor Austin Smith (left) and Professor Oliver Brüstle

For more information, please contact Professor Austin Smith (agssec@cscr.cam.ac.uk) or visit the Cambridge Stem Cell Initiative website (www.stemcells.cam.ac.uk/).



A conservation leader in the making

Joy, working with Fauna & Flora International (FFI) in the Caribbean

Joy Juma is among the first early-career conservation practitioners to take an innovative Masters programme at the University of Cambridge.

Cycling to lectures through Cambridge's medieval streets, learning leadership skills from pioneers in conservation of the environment, splashing into the turquoise waters of the Caribbean to observe marine life. These are among the many memories that Joy Juma will take home to Kenya after a year at the University of Cambridge as one of the first cohort of graduate students on the MPhil in Conservation Leadership programme (see panel).

The past year has been one of the most varied and demanding in Joy's life. Not only has she experienced one of the coldest British winters on record but she also spent seven weeks on a placement with the Cambridge-based conservation organisation Fauna & Flora International (FFI) on the islands of Antigua and Barbuda, extending her practical and grass-roots knowledge of marine conservation.

Her visit to the Caribbean entailed gathering data on the marine environment and the ways in which it intersects with two of the area's most important sources of revenue – fishing and tourism – which are vital to the livelihoods of thousands of people on modest or low incomes. The emphasis of her research was on marine governance. "On Antigua, I was based at the Fisheries Division of the Ministry of Agriculture, Lands, Housing

and the Environment, and also spent some time talking to individual fishermen about their working lives. It was so encouraging that the fishermen are really keen to conserve their environment and they showed a deep understanding of ecosystem dynamics," she said.

"On Barbuda, I found that people felt an even stronger sense of ownership of the marine environment, perhaps because land there is communally owned. This revealed itself in their interest in marine conservation. On both islands, there is a profound commitment to sustainable management and a willingness to work towards this that was really exciting. It shows how conservationists and communities can work together to protect threatened species and the habitats they live in. What emerged most forcefully from my placement was the similarity of conservation problems globally and the opportunities for learning from each other."

Once back in Kenya, where she works for the East African arm of FFI, Joy will apply her experiences in the Caribbean and what she has learnt on the MPhil programme in Cambridge. In 2009, together with colleagues at FFI, she was instrumental in setting up marine conservation projects with fishing communities at six different landing places on

MPhil in Conservation Leadership

Launched in 2010 by the Department of Geography, the MPhil in Conservation Leadership focuses on equipping its students with the tools to become professional managers in the world of conservation. Key to its success is the collective expertise of partners in the Cambridge Conservation Initiative (CCI; www.conservation.cam.ac.uk/): eight leading conservation organisations and one conservation network clustered in the Cambridge area and six departments across the University, including the Cambridge Judge Business School and the Cambridge Programme for Sustainability Leadership.

Students go beyond developing a deeper awareness of the complex drivers of biodiversity loss to learn skills that will prepare them for the challenges of leadership: strategic planning, finance, innovation, entrepreneurship, advocacy and communication.

The Director of Conservation Leadership, and Fellow of Churchill College, Dr Nigel Leader-Williams, explained: "The programme is built along similar lines to the business school model, with a professional placement spent with one of CCI organisations providing the students with hands-on experience of management tasks."

Many of the students are from less-developed countries, where the most biodiversity remains but also where the losses are probably the greatest. "We need to grow the number of dedicated scholarships that are available for the course because most of the students we aim to attract don't have the funds necessary to cover the costs of the course," added Dr Leader-Williams. The programme is supported for a period of 10 years by a generous gift from the MAVA Fondation pour la Protection de la Nature, while Arcadia has agreed to establish a Miriam Rothschild Scholarship Programme in Conservation Leadership for the next five years.

As the first cohort of students complete their studies and resume their careers in conservation around the globe, the contacts they have made will be invaluable. This, explained Dr Mike Rands, Executive Director of CCI, is a strategic aim of the programme: "With successive years, this innovative course will create a growing international leadership network, build conservation capacity and become a major force for better environmental stewardship."

For more information, please contact Dr Nigel Leader-Williams (nigel.leader-williams@geog.cam.ac.uk) or visit www.geog.cam.ac.uk/graduate/mphil/conservation/



The Conservation Leadership students 2010–11 on a field trip to the Norfolk Broads

DR NIGEL LEADER-WILLIAMS

the south coast of Kenya. The objective is to manage marine resources in a way that is sustainable and participatory. "It's a scheme that brings diverse stakeholders together for a common purpose – and the early indications are that it is very effective," she explained.

"What emerged most forcefully from my placement was the similarity of conservation problems globally and the opportunities for learning from each other."

Joy has been passionate about conservation ever since she was a teenager. On leaving school, she took a degree in environmental studies at Nairobi's Kenyatta University, concentrating on community development. After graduating, she spent a year working as a volunteer for the East African Wildlife Society, a Kenyan-based NGO. "I worked on the restoration of a lake that straddles the boundary between Kenya and Tanzania, and during this time I gained essential skills and experience," she said. Having excelled as a volunteer, and shown

her ability to co-ordinate and manage projects, Joy was offered a post with FFI as a programme assistant. After four years she was promoted to a programme co-ordinator.

In East Africa, FFI works across four countries – Kenya, Tanzania, Uganda and Sudan. In her five years with the organisation, Joy has been involved in various projects, including participatory forest management and species recovery. During this time she twice visited the headquarters of FFI, which has strong links with Cambridge University as a founding partner of the Cambridge Conservation Initiative (CCI). "I liked what I saw of Cambridge, which is a real hub for conservation and has a strong international ethos. So when I heard about the new Masters in Conservation Leadership, I was really keen to apply for a place," she said.

"What appealed to me about the course was the chance to develop skills that are crucial in project management. I liked the way in which the course is structured to give participants a solid grounding in leadership – such as communication and financial planning – as well as incorporating a placement with a partner organisation that would offer a chance to see another environment and another set of challenges."

When FFI and the MAVA programme in Conservation Leadership agreed to sponsor

Joy's place on the programme, she was thrilled but also nervous. "I knew it was a huge opportunity to develop myself professionally. I was also aware that I'd be thrown back on my own resources far from my usual support network in East Africa," she admitted. She need not have worried. The 12 students from nine different countries on the programme quickly formed a strong bond. "We have a huge diversity of backgrounds and interests, so we have been able to learn a vast amount from each other," she said.

The Masters comprises two parts: the first of which is largely taught by lecturers from every organisation in CCI, talking about their specialist fields, and the second of which is the placement. "In the first two terms we had lectures from many of the pioneering groups and centres based in and around Cambridge – it was an amazing chance to hear from them and to be able to ask questions. What I found especially useful were the leadership lectures from people at the helm of established institutions," added Joy.

Life as a Cambridge student has been rewarding and challenging. "Spending a year living and working in Cambridge has been a stimulating experience. I will be returning to Kenya ready to be an innovative and effective conservation leader."

Reporting by Alex Buxton

Excavation of 19,000-year-old hunter-gatherer remains, including a vast camp site, is fuelling a reinterpretation of the greatest fundamental shift in human civilisation – the origins of agriculture.

From foraging to farming: the 10,000-year revolution

The moment when the hunter-gatherers laid down their spears and began farming around 11,000 years ago is often interpreted as one of the most rapid and significant transitions in human history – the ‘Neolithic Revolution’.

By producing and storing food, *Homo sapiens* both mastered the natural world and took the first significant steps towards thousands of years of runaway technological development. The advent of specialist craftsmen, an increase in fertility and the construction of permanent architecture are just some of the profound changes that followed.

Of course, the transition to agriculture was far from rapid. The period around 14,500 years ago has been regarded as the point at which the first indications appear of cultural change associated with agriculture: the exploitation of wild grains and the construction of stone buildings. Farming is believed to have begun in what is known as the Fertile Crescent in the Levant region, which stretches from northern Egypt through Israel and Jordan to the shores of the Persian Gulf, and then occurred independently in other regions of the world at different times from 11,000 years ago.

Recent evidence, however, has suggested that the first stirrings of the revolution began even earlier, perhaps as far back as 19,000 years ago. Stimulating this reinterpretation of human prehistory are discoveries by the Epipalaeolithic Foragers in Azraq Project (EFAP), a group of archaeologists and bioarchaeologists working in the Jordanian desert comprising University of Cambridge’s Dr Jay Stock, Dr Lisa Maher (University of California, Berkeley) and Dr Tobias Richter (University of Copenhagen).

Over the past four years, their research has uncovered dramatic evidence of changes in the behaviour of hunter-gatherers that casts new light on agriculture’s origins, as Dr Stock described: “Our work suggests that these hunter-gatherer communities were starting to congregate in large numbers in specific places, build architecture and show more-complex ritual and symbolic burial practices – signs of a greater attachment to a location and a changing pattern of social complexity that imply they were on the trajectory toward agriculture.”

Fertile Crescent

Working at the fringes of the Fertile Crescent, at sites in the Azraq Basin and the marshlands of Jordan, the EFAP team is excavating the archaeological remains of the hunter-gatherers who occupied the region. Such sites have been under studied, said Dr Stock: “Because these early hunter-gatherers have been perceived as building only transient camp sites, they have been largely disregarded in explanations of the development of agriculture. Instead, excavations have focused on the later ‘Natufian’ period, beginning around 14,500 years ago, since this period more clearly shows cultural precursors of the transition to agriculture.”

Today, the Azraq Basin is a 12,000 sq km area of dusty, wind-blown desert, and a very challenging place to work. Temperatures can soar to 45°C, requiring the researchers to start field work at 5 am and finish by midday when the heat and winds become too strong to allow work to continue.

But when the first humans were leaving Africa, the open grasslands and lush marshlands of the Fertile Crescent teemed with gazelle, antelope and plant life. Given this region is situated at the crossroads between Africa and the rest of the world, it is perhaps unsurprising that it should be the site of regional agricultural innovation.

Few previous archaeological excavations have been carried out in this inhospitable terrain, most instead focusing on regions closer to the Mediterranean. With funding from the Arts and Humanities Research Council, the researchers set out four years ago to redress the balance.

Complex burials

Dr Stock’s expertise lies in the analysis of hunter-gatherer bones. Over the past 15 years, he has analysed over 1,400 skeletons from around the world to understand what it is about early humans that made them such successful colonisers of the natural environment.

One of the most startling of the researchers’ findings in Jordan has been the hunter-gatherer graves. Evidence suggests that, far from simple burials, the hunter-gatherers had elaborate mortuary and sociocultural practices. In one grave in



‘Ayn Qasiyya, an adult male was placed in marshland in a sitting position, and was likely to have been tightly wrapped in cloth. A previous finding by another archaeologist at Kharaneh IV was a burial of an older man underneath a hut floor, his age suggesting that he would have required the care of others in life.

At another site, ‘Uyun-al-Hammam, a University of Toronto-based project led by Dr Maher has excavated a total of 11 burials, some of which show elaborate mortuary treatments. Indeed, one grave that includes a human buried together with a fox, said Dr Maher: “suggests a close emotional or symbolic tie between humans and foxes prior to the first domesticated animal – the dog – and shows continuity in burial and social practices with the later Neolithic”. Dr Stock’s



WADI ZIQLAB PROJECT

“Because these early hunter-gatherers have been perceived as building only transient camp sites, they have been largely disregarded in explanations of the development of agriculture.”

study of the human remains demonstrates that these people were ancestral to the later farmers.

The researchers argue that these examples may represent an increasing cultural sophistication and a greater complexity in the relationship between humans and animals – trends that had only previously been identified in later time periods.

Mega camp site

A major focus of the work of the EFAP team over the past four years has been the excavation of the site of Kharaneh IV, in the Azraq Desert of eastern Jordan. The site is much more than the sort of temporary camp site normally ascribed to hunter-gatherer groups. Covering almost two hectares, the 19,000-year-old site was occupied for 1,200 years and is, as Dr Stock described, “so huge, it’s the earliest sign of human activity that is large enough to be visible on Google Earth.”

“To produce the debris of stone tools and bones, in some places almost 3 m deep, we believe that many groups of hunter-gatherers would meet and live together for several months of the year before splitting into mobile groups at other times.”

The team is researching the area in astonishing detail – in a technique known as 100% flotation, every square centimetre excavated is floated to check for plant remains and charcoal. As Dr Richter pointed out: “even very small remains are providing very important clues towards our understanding of the relationship between prehistoric humans and their habitat”.

To date, they have found plant remains, animal bones carved with repeated incised motifs, stones carved with geometric patterns, stone tools in their thousands, hearths, pierced shells and, just recently, oval hut structures. As the work continues, all indications point towards an advanced cultural and technological complexity in the exploitation of bone, shell, plants and architecture. “The size of the site, combined with evidence for huts and other symbolic goods, imply that Kharaneh IV was long-term and repeatedly occupied,” said Dr Stock. “It could be regarded as a precursor to later farming villages.”

The revolution that wasn’t

The team’s discoveries extend many aspects of the behavioural complexity associated with the Neolithic to about 10,000 years earlier, pushing back the true roots of the transition to agriculture.

“On evolutionary timescales, the transition to agriculture can undoubtedly be regarded in revolutionary terms,” said Dr Stock. “But, we can now see this as a culturally dynamic process that began much earlier than previously thought.”

“This picture would not have come together through the excavation of one site alone,” he added. “The burial complexity of ‘Uyun-al-Hammam and ‘Ayn Qasiyya, together with the architecture and size of the settlement at Kharaneh IV, collectively offer glimpses of a protracted period in which humans worked through the cultural and biological changes that needed to happen before village life and the systematic exploitation of grain could emerge.”

Was this hunter-gatherer on the cusp of agriculture? Excavation of sites in Jordan, including ‘Uyun-al-Hammam where this 16,000-year-old skeleton was discovered, suggests that hunter-gatherers were closer to becoming farmers than previously thought



Dr Jay Stock

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Cambridge scientists, and their map-making skills, are contributing to an annual worldwide public health endeavour – the race to select a vaccine against seasonal flu.

A global killer that eludes capture by changing its coat, influenza is one of the world's most intractable viruses and consuming public health challenges. It infects 5–15% of the world's population and kills up to about half a million people each year; a figure that rose to many millions in the three major flu pandemic outbreaks that have occurred in the past century. In a single year in 1918, flu claimed more than five times the number of lives than were lost during the World War that preceded it.

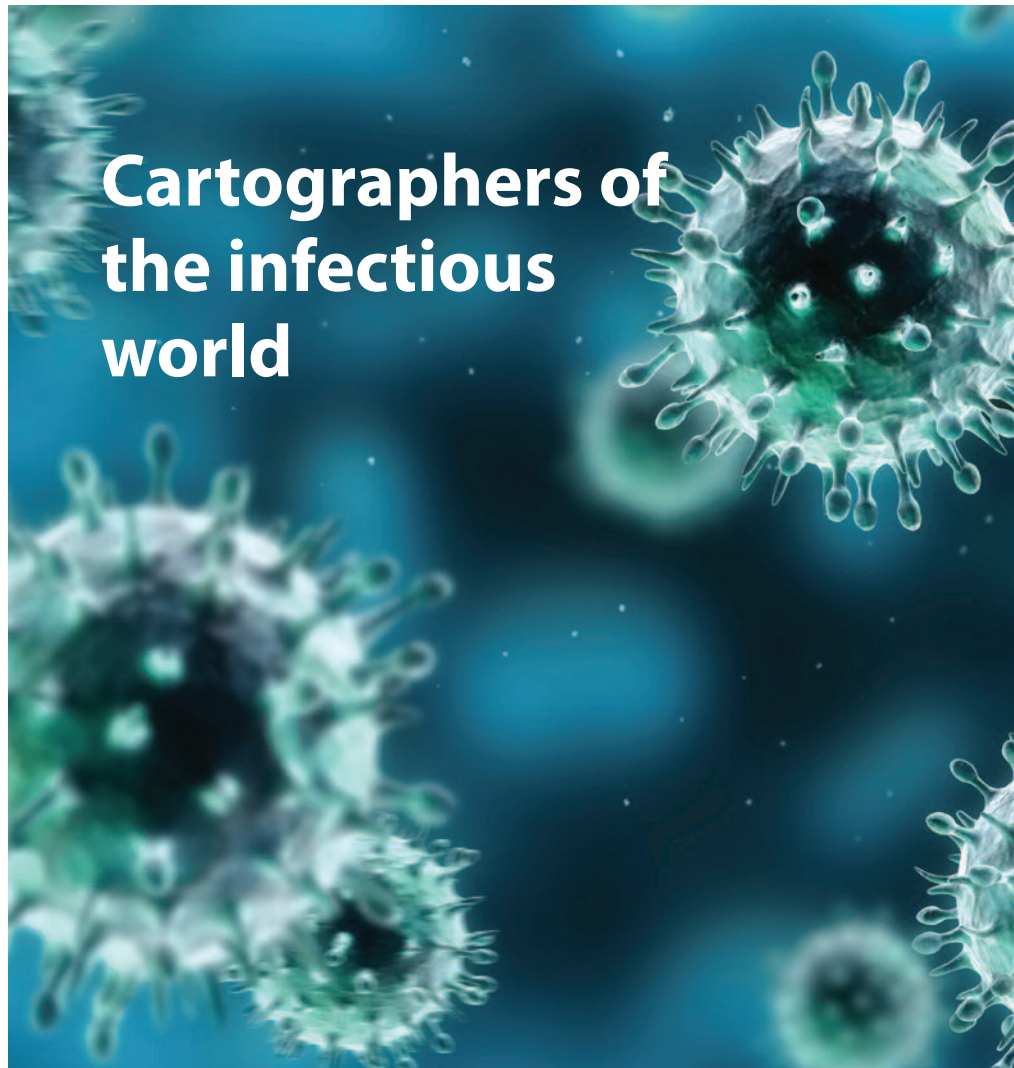
It is the coat-changing behaviour that makes flu such a problem. The part of the virus that our immune system recognises is its outer coat. By changing the shape of the viral glycoprotein haemagglutinin that makes up most of this coat, the virus escapes destruction and begins the infectious process that spreads rapidly throughout the upper respiratory tract. Alarmingly, these so-called antigenic differences in the viral coat can evolve so quickly that a vaccine in use one year may be obsolete the next.

Spearheading the race to identify the best vaccine to combat seasonal flu, the World Health Organization (WHO) organises a consultation to make recommendations about the composition of the vaccine in February for the upcoming northern hemisphere's flu season and in September for the southern hemisphere.

"It's a very high-risk public health decision – 350 million people get vaccinated with the flu vaccine every year – so a lot rides on the decision of the committee," said Derek Smith, Professor of Infectious Disease Informatics in the Department of Zoology. Since 2004, Professor Smith has been a member of the group responsible for making these crucial recommendations.

"It's a huge responsibility and so every analysis that can be used is used," he added. One analysis that is transforming how scientists track changes in the virus is antigenic cartography. Developed by Professor Smith with Dr Alan Lapedes (Los Alamos National Laboratory, New Mexico) and Professor Ron Fouchier (Erasmus Medical Center, Rotterdam), and first published in *Science* in 2004, the technique is useful not only for tracking the past evolution of the virus but also holds promise for predicting what comes next.

Cartographers of the infectious world



Global surveillance and map making

For over six decades, the WHO has orchestrated a remarkable global system to protect us against seasonal flu. Each year, 10,000–20,000 samples of the virus are isolated from throat swabs of patients presenting with flu-like symptoms by members of the WHO Global Influenza Surveillance Network in 105 countries. Many of these strains are then sent to one of the five WHO Collaborating Centers located in the USA, the UK, Japan, China and Australia.

And so begins the massive task of collating information about the flu viruses in circulation worldwide in the preceding months: to what extent the viruses differ genetically, epidemiologically and serologically; how fast they are spreading and to which global region; and how well current vaccines are likely to protect against them.

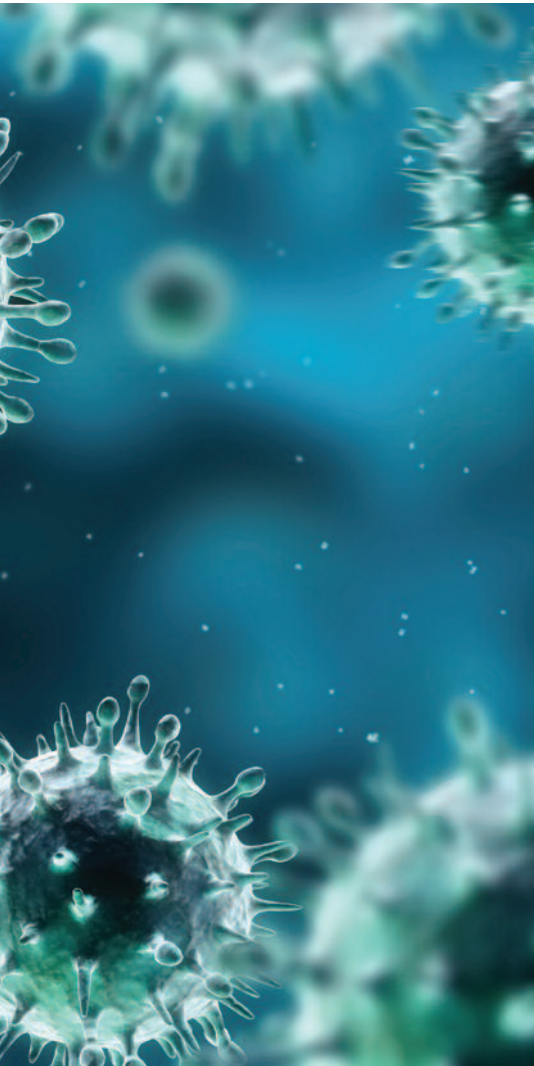
The most critical data for the vaccine recommendation come from the detailed antigenic analyses of the virus strains – essentially this gives the scientists a sense of how well our immune system, induced by prior infection or vaccination, will recognise a virus.

"For many years, people have looked at data for antigenic differences between

pathogens in numerical, tabular form, but this is inherently difficult because of paradoxes that were not previously understood. Not many people can make accurate inferences from such data," said Professor Smith. "We wanted to understand these paradoxes and be able to look at fine-grain differences between strains, and we wanted to interpret them in a more visual way."

He likens the process to a road atlas. Just as understanding the relationship between different cities is difficult to visualise from a table of distances and yet easy to see on a road atlas, so too is the relationship between different viruses clearer when a table of lines of numbers is translated into a two-dimensional graphic. The end result – a series of coloured dots, each representing clusters of similar viruses – even resembles the geographical scattering of cities across a landscape.

"We use data from experiments that test how well antibodies bind to each strain's coat protein and turn this into a geometric interpretation in which each antigen, and the antibodies against it, are assigned a point on an antigenic map," Professor Smith explained. "Computationally it's not complicated so it's fast and fortunately it's also visual –



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Influenza virus

Scientists have long wondered whether influenza epidemics arise from locally persisting strains or whether they are 'seeded' from other regions of the world. When Dr Russell looked at the maps of H3N2, it was clear that the viruses originated in East and Southeast Asia and then reached North America and Europe via Oceania after 6–9 months, finally ending up in South America a few months later. Once the H3 viruses leave Asia they rarely return, and thus regions outside of East and Southeast Asia are considered the 'evolutionary graveyards' of influenza viruses.

This information highlights the importance of ongoing collaborations and surveillance in East and Southeast Asia, as Dr Russell explained: "If we see an H3 virus in the region that has undergone a change then we know that we're likely to see that in the northern hemisphere at some stage. It gives us a head start on what might happen next."

"Many of the important pathogens that remain today are the pathogens that evolve," added Professor Smith. "Flu vaccine is currently the only vaccine against an antigenically variable pathogen and the only one licensed to be updated every year. But as vaccines become available against dengue, HIV and so on, they would probably have to be updated too and it's likely that similar worldwide monitoring systems will also be needed to track movement of these viruses."

two criteria that are very important when dealing with large amounts of information of this type."

The computer program is freely available as open source software at www.antigenic-cartography.org/. Today, laboratories worldwide, including Professor Smith's, are now using the software to map diseases such as HIV, malaria, dengue fever and rabies, as well as Smith's first love, influenza.

Have new coat, will travel

Significantly, the maps can be used to trace the evolution of different strains as they move around the globe. When Dr Colin Russell, Professor Smith and colleagues analysed 13,000 samples of influenza A (H3N2) virus from the WHO Global Influenza Surveillance Network, they were able to see how over the course of five years the virus drifted away from the original strain to form a series of new antigenic clusters of progressively different strains. Each time this cluster transition happens, a new vaccine is needed.

Not only was this experiment, which was published in *Science* in 2008, the first time that the evolution of a virus had been tracked in detail in this way, but it also provided an answer to the mystery of how flu circulates around the world.

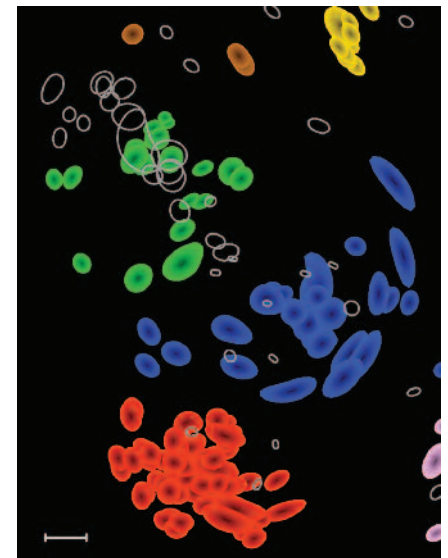
Predictive power

Currently, recommendations for influenza vaccine are based on the evaluation of past data. But what the scientists would like to do is use antigenic cartography as a means of predicting how the virus will evolve ahead of the event.

"In Cambridge, and with colleagues at Erasmus University, the primary aim now is to see how predictive this evolution is and to move the prediction horizon to a year ahead," commented Professor Smith, who with Dr Russell and their team now analyses up to 20,000 flu viruses a year.

"We already have some indications that this is possible for influenza and, if so, the public health implications are vast – from predicting at a much earlier stage which vaccine might be best, to predicting where in the world the virus might migrate to next."

"It's fast and it's also visual – two criteria that are very important when dealing with large amounts of information of this type."



PROFESSOR DEREK SMITH

An antigenic map of influenza viruses: each virus strain appears as a small coloured blob, each antiserum as an unfilled blob; the scale bar represents one antigenic unit, a measure of how similar are the strains



Professor Derek Smith (left) and Dr Colin Russell

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The research was funded by the National Institutes of Health Director's Pioneer Award Program, which supports 'individual scientists of exceptional creativity who propose pioneering – and possibly transforming approaches – to major challenges in biomedical and behavioral research'. The group is also funded by the European Union, Wellcome Trust, Royal Society, Bill & Melinda Gates Foundation and Human Frontier Science Program.

New research has identified communication gaps that could hinder the deployment of carbon dioxide capture and storage (CCS) technologies to mitigate climate change.



Demonstration banner by climate change activists

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Deep issues: communicating CCS

CCS has been described by advocates as the single biggest lever to combat climate change. The technology – which aims to capture carbon dioxide generated by fossil fuel power stations and store it safely and permanently deep underground – has, said Rt Hon. Chris Huhne MP, UK Secretary of State for Energy and Climate Change, “a key part to play in ensuring that we can keep the lights on at the same time as fighting climate change.”

Despite the enthusiasm, no commercial-scale CCS projects for power plants are yet in operation. For governments and industry, the main barrier is cost. By contrast, for environmental groups, concerns have been voiced about the continued use of fossil fuels and the impact on their preferred options such as renewable energy sources.

Concerns about CCS also extend to local populations, as Dr David Reiner from Cambridge Judge Business School explained: “Recent early stage CCS projects in Germany, the Netherlands and America have all generated substantial local opposition and led to projects failing. Aside from technical progress that will bring down costs, more needs to be learned about what factors will affect the chances of CCS becoming widely adopted.”

His research team, together with colleagues from across Europe, has focused on how information about CCS is communicated, asking whether key lessons can be learned that will affect the technology’s deployment.

Communication strategy

A key step was to carry out a global review of CCS communication practices: who is communicating what aspects of CCS, and why? “We found that most CCS communication, which is principally via websites, is very good at explaining the technological processes involved. But, in areas that are likely to be of most concern to society, such as costs, policy alternatives and wider social implications, there is scant

coverage,” said Dr Reiner. “Moreover, most of the information about CCS is from sources that are perceived by the general public as ‘less trusted’, such as business and governments, rather than research institutions, established media or NGOs.”

These are serious obstacles believe the researchers, particularly as their findings indicate that environmentalists base their evaluations about CCS on what role they believe it will play in society rather than on whether they think CCS technology works or not. This view of environmental activists is based on data the researchers gathered in Climate Camps – grassroots movements that advocate direct action on climate change – and Green Party conferences in the UK. Participants at both displayed considerable understanding of the issues involved.

When it comes to the general public, though, the level of understanding of CCS was found to be considerably less. The research team investigated the opinions and perceptions of CCS by residents in five European Union member states who live in the region of planned projects. “One major finding was that if the residents felt that the planning process was fair or that their local community had been treated fairly in the past, this had a direct relationship to their attitudes towards the local project,” added Dr Reiner.

Avoiding a ‘perfect storm’

“Our research has shown that many of the first projects have engendered a type of ‘perfect storm’, whereby the communication with the local community is problematic, is presented as a *fait accompli* and is provided by ‘less-trusted’ sources, such as the developers,” explained Dr Reiner. “In addition, the community is frequently sceptical from the start because of previous bad experiences with local infrastructure planning.”

The researchers believe that improving communications and thinking more carefully about the social characteristics of the project

at the design stage will reduce the likelihood of opposition. Under certain conditions, they found that even many strident environmental activists are willing to support (or at least not oppose) CCS.

“There is no magic formula,” he added, “but taking the extra time needed to bring in more-trusted voices such as university scientists or environmental groups will increase the likelihood that these first projects, and ultimately CCS more generally, will be successful.”

Cambridge Centre for CCS Studies

A recently launched Centre, led by Director Professor Mike Bickle (Department of Earth Sciences), with Dr Stuart Scott (Department of Engineering) and Dr David Reiner, will facilitate collaborative research and act as a focal point for CCS research at Cambridge.

For more information, please visit www.ccs.cam.ac.uk/



Dr David Reiner

For more information, please contact Dr David Reiner (dmr40@cam.ac.uk) at Cambridge Judge Business School (www.jbs.cam.ac.uk/).

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Research online

If you're interested in the latest research from the University of Cambridge, take a look at our dedicated research website at www.cam.ac.uk/research/

Here you'll find news, features, videos and audio covering research across the disciplines, all in a fully searchable and easy-to-use format. We've also created themed areas, bringing together articles on subjects as diverse as energy, neuroscience, international development and food security. Look out for the latest theme, language sciences, or see the full range of themes at www.cam.ac.uk/research/themes/

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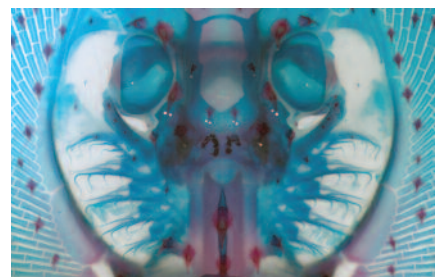
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