CAREERS

COLUMN A love affair with research can break your heart, too **p.155**

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The neuronal pathways in the brain's white matter are picked out in this magnetic resonance image.

NEUROSCIENCE

A head start for brain imaging

With several big data projects under way, there is growing demand for neuroimaging expertise.

BY VIRGINIA GEWIN

Corey White felt pretty fortunate during his job search late last year. Over the course of 4 months, he found at least 25 posts to apply for — even after he had filtered the possibilities to places where his wife also had job prospects. Competition for the jobs was, as he expected, fierce, but he secured three interviews. In the end, he says, it was his skills in functional magnetic resonance imaging (fMRI) that helped him to clinch a post at Syracuse University in New York, where they were eager to elevate their neuroscience profile.

The human brain is something of an enigma. Much is known about its physical structure, but quite how it manages to marshal its myriad components into a powerhouse capable of performing so many different tasks remains a mystery. Neuroimaging offers one way to help find out, and universities and government initiatives are betting on it. Already, an increasing number of universities across the United States and Europe are buying scanners dedicated to neuroimaging — a clear signal that the area is set for growth. "Institutions feel an imperative to develop an imaging programme because everybody's got to have one to be competitive," says Mark Cohen, an imaging pioneer at the Semel Institute for Neuroscience and Human Behavior at the University of California, Los Angeles.

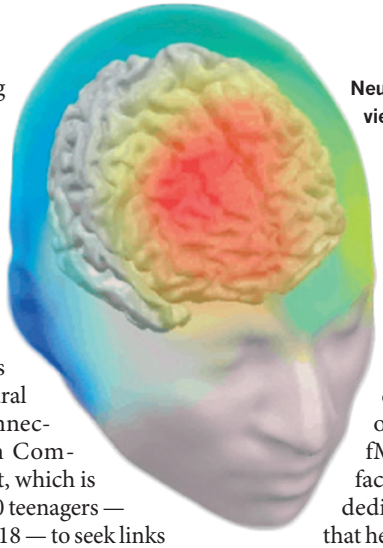
At the same time, a slew of major projects focusing on various aspects of the brain is seeking to paint the most comprehensive picture yet of the organ's organizing principles — from genes to high-level cognition. As a result, young scientists with computational expertise, a fluency in multiple imaging techniques and a willingness to engage in interdisciplinary collaborations could readily carve out a career in this dynamic landscape.

INSIDE THE MIND

Several imaging techniques are experiencing fresh demand. The development of tracers that bind to the β-amyloid proteins that form the plaques associated with Alzheimer's disease has reinvigorated the use of positron emission tomography (PET), for example. PET scans can now be used to detect the earliest stages of Alzheimer's disease, which could aid the development of effective treatments. And fMRI, which detects changes in blood flow, is now being used to identify neural networks involved in cognitive function, to recognize and diagnose neurodegenerative diseases and to assess treatments or therapies (see *Nature* **484,** 24–26; 2012). Researchers have also combined fMRI skills with novel optogenetic techniques, which use genetic controls to activate specific neurons in order to track neuronal activity in live animals.

These imaging techniques are being pulled together in a number of big projects that aim to integrate findings on the molecular, cellular and whole-brain scales. In January, the European Commission announced that it would fund the 10-year Human Brain Project at roughly €1 billion (US$1.4 billion); the project has the ambitious aim of producing realistic computer simulations of the brain, all the way from individual cells to the entire organ (see *Nature* http://doi.org/phz; 2013). Some 250 scientists from 80 groups are involved so far, says Richard Frackowiak of the University of Lausanne in Switzerland, who is one of the project's co-leaders. He expects that number to grow in future funding rounds.

In the United States, the US$110-million Brain Research through Advancing Innovative Neurotechnologies (BRAIN) Initiative, announced in April, will map the brain's activity in exquisite detail, with imaging likely ▶



Neuroimages explore real-time views into cerebral function.

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to be among the funding priorities (see page 26).

Technological advances in neuroimaging are the foundation of other big, interdisciplinary collaborative efforts, such as the Human Connectome Project, funded by the US National Institutes of Health (NIH), which is mapping the brain's structural and functional neural connections; and the European Commission's IMAGEN project, which is scanning the brains of 2,000 teenagers — at the age of 14 and again at 18 — to seek links between brain structure, risk-taking behaviour and mental health. "Even though studying diseases is a big driver in neuroscience, we've put increasing effort into understanding how healthy brains work," says IMAGEN scientist Christian Büchel, director of the neuroimaging centre at the University Medical Center Hamburg-Eppendorf in Germany.

Although these big projects offer significant career opportunities, there is a potential downside that researchers need to keep in mind, says Ray Dolan, director of the Wellcome Trust Centre for Neuroimaging at University College London. Search committees typically place a premium on independence and individual initiative. "I worry about top-down initiatives creating an army of workers who, when the projects are done, are no longer attractive as potential hires by universities because they haven't developed the ability to generate their own ideas," he says. Even so, Dolan believes that neuroimaging skills allow researchers to cross disciplinary boundaries relatively easily.

BEYOND NEUROSCIENCE

The university neuroimaging boom is not confined to neuroscience departments. There is a real hunger for ways to quantify brain and behaviour in psychology and psychiatry, says Graeme Mason, director of the neuroimaging-sciences training programme at Yale School of Medicine in New Haven, Connecticut.

Most of the faculty positions in established disciplines, such as cognitive psychology, require neuroimaging skills. And neuroimaging has fuelled the rapid growth of subfields such as neuroeconomics, which looks at human decision-making, and social neuroscience, which studies disorders and the development of human social behaviour. Todd Heatherton, a cognitive neuroscientist at Dartmouth College in Hanover, New Hampshire, and a frequent job-search chair, says that, until recently, social neuroscience had more jobs available than there were truly qualified applicants — those with both the computational skills and an appreciation of social psychology. Competition for the top applicants remains fierce, he says.

For many young neuroscientists, the biggest concern is the lack-lustre state of federal funding in some countries, especially given that scanning programmes are costly to get up and running. At Syracuse University, White is one of the few people doing fMRI studies. Given that the facilities he uses are not solely dedicated to research, he fears that he would struggle to meet the criteria for an NIH grant to fund his work on cognitive behaviour. So he is trying to bolster his chances by setting up cross-disciplinary collaborations that take advantage of local expertise in genetics, cardiovascular health or exercise science. Already he has been talking to an exercise scientist about relating the metrics of artery stiffness to cognitive processing.

It is not a bad strategy. Carolyn Asbury, a consultant for the Dana Foundation, a non-profit organization in New York city that is dedicated to neuroscience, says that funding applications have become increasingly interdisciplinary and collaborative during the past decade, often combining different imaging techniques. The foundation allocates at least half of its annual funds of some $2.8 million to support budding neuroscientists starting careers. It is particularly interested in proposals involving cellular and molecular imaging techniques, such as developing new tracers for use in PET.

Funders are also increasingly interested in applied clinical uses of neuroimaging techniques, which open yet more avenues for collaboration. For example, the European Commission in September put €4.2 million into a €6-million project called METSY. This aims to identify neuroimaging biomarkers of psychosis and to study the links between psychotic disorders, such as schizophrenia, and other conditions, such as obesity and diabetes.

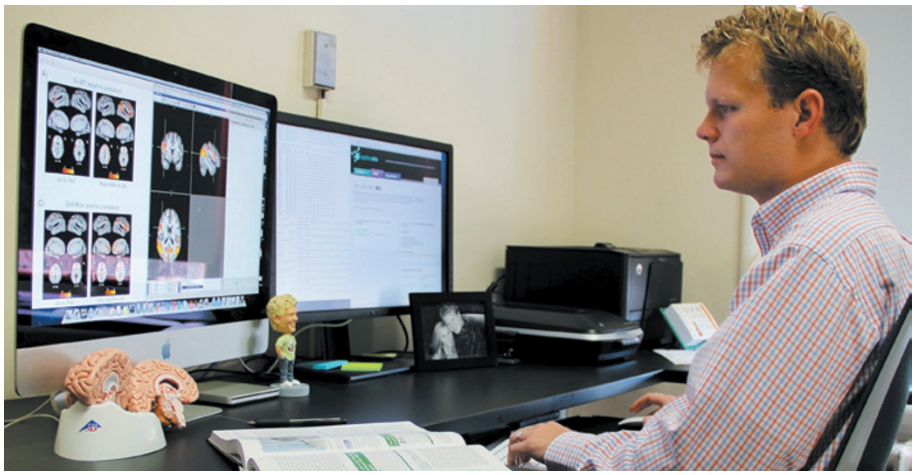
In Switzerland, the Translational Neuromodeling Unit at the University of Zurich has brought clinicians, neuroimagers and computational analysts together under one roof to develop diagnostic tools based on models to offer treatment recommendations and predict clinical outcomes for psychiatric patients. And in September the Kessler Foundation in West Orange, New Jersey, opened the first independent neuroimaging-focused rehabilitation institute in the United States, where it will conduct research and clinical trials aimed at bolstering recovery from brain trauma.

Companies also see the potential for imaging to become a staple of health care and drug development. Bin He, director of the Center for Neuroengineering at the University of Minnesota in Minneapolis, says that his graduate students sometimes end up working at major imaging companies. Philips recruited one of his students last year, he says, and companies such as Siemens, General Electric and Medtronic are also looking for neuroimaging talent. Russell Schramm, head of talent acquisition for Philips North America, says that imaging systems will be a key area of focus for the company's health-care business over the next five years. Projects such as the Alzheimer's Disease Neuroimaging Initiative — an effort funded in part by the Alzheimer's Association to study changes in cognition, function and brain structure in elderly people — could have an impact in the clinic and spark interest from industry, he says.

SURVIVAL SKILLS

To capitalize on the opportunities for neuroimaging, it is important to gain the appropriate statistical and computational skills. This means taking advanced statistics courses and learning a programming language.

"Neuroimaging is now seen as a quantitative field — built on real data, not clever parlour tricks — that has an impact in a variety of areas of medicine," says Cohen. Computational skills, including multimodal analyses,



ALEXANDRIA WEAVER

Corey White hopes to build interdisciplinary collaborations that capitalize on his fMRI skills.

signal processing and parametric statistical modelling, are key to successful analyses. "It takes quite a bit of skill to look at data and identify what is artefact versus what is real and important," Cohen says.

Russell Poldrack, director of the Imaging Research Center at the University of Texas at Austin, doesn't even bother to interview applicants who can't write computer code. Data sets are getting so big that trying to analyse them without using automated methods simply takes too long, he says. Off-the-shelf software packages tend not to lend themselves to the most interesting and novel analysis methods, Poldrack notes, so he wants people who can write programs that can do those analyses.

Computational skills have become so important that, in July, Dartmouth College hired Alireza Soltani, a computational neuroscientist with a background in theoretical physics, to model other people's data rather than collect his own. Soltani uses detailed computational modelling at the synaptic, cellular and network levels to look for mechanisms that help to explain behaviour and cognition. This hiring strategy is necessary to ensure that the college has the people "with the skills to advance the field beyond pretty pictures", says Heatherton.

As universities increase their neuroimaging capacity, they are facing a recruitment challenge. "The applicant pool for neuroimaging posts is diversified and of variable quality," says Kamil Ugurbil, director of the Center for Magnetic Resonance Research at the University of Minnesota. It can be difficult to find good people with rigorous computational skills in neuroimaging, he notes. At the same time, physicists, engineers and statisticians can have quantitative skills but lack the psychology or life-sciences background for a neuroimaging-related post.

Even those who can offer the right mix of skills should consider gaining expertise in more than one imaging technique. "We all need to specialize to some extent, but it's more advantageous to be well versed in a range of complementary techniques to avoid being labelled as just the PET guy or just the fMRI guy," says Brian Bacskai, a neuroscientist at Massachusetts General Hospital in Boston, whose work combines cellular and molecular imaging techniques to study Alzheimer's disease.

Bacskai reiterates the importance of collaboration for neuroimaging. "Cross-disciplinary studies are the only way to move the field forward," he says. "I think institutions will look at how good applicants are at working with others as a key factor in a CV or tenure package." ■

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COLUMN

Postdoc's torch song

A love affair with research can be just as heartbreaking as romantic love, says **Christopher Schmitt**.

Maybe it was never meant to be.

Such was my resigned perspective when I was dumped by a boyfriend while conducting my doctoral field research. I had been studying the behaviour of wild spider monkeys and woolly monkeys in the Amazon for six months, and as the data had been slowly coming in, my relationship had been slowly deteriorating. Communication had devolved from lengthy nightly video chats — me providing virtual tours of the field station and images of monkeys, him displaying Manhattan skyscapes — to a slow fade of curt, non-committal missives that bred a terrible uncertainty. When I saw him smiling with an unfamiliar man on my social-network newsfeed, I knew which way the wind was blowing.

But it was OK. I was getting my data. I was working towards a doctorate and an academic career, something bigger than that relationship. And I knew that once I recovered from being dumped by instant message, I could find another man — a better man! — who would be more supportive of my increasingly demanding relationship with my work. My research seemed to offer the affirmation and validation that my personal relationships had stopped providing. After all, I thought, it could never cut me off the way my now ex-boyfriend had.

I did get my doctoral degree. I got grants. I published. I landed a promising postdoc post across the country from my graduate school; I could check out a new dating pool while leaning on my more gratifying love affair with science.

Now I am three years into a postdoc that has been not quite as productive as promised. The wait for overdue data from collaborators has made me miss my funding deadlines. When I do pitch my research to funders and foundations, they send me curt summary statements wondering about my lack of post-doctoral publications. Letters to tenure-track university job-search committees come back with polite but deflating responses.

It's the slow fade all over again.

Of course, my challenges are not uncommon. Postdocs in the current market, especially in the life sciences, have little chance of landing the tenure-track posts they had in mind when they started out. The dire situation in the US job market was exacerbated by a massive increase in trainees in the early 2000s with no increase in faculty positions, and may well be amplified by sequestration, that package of deep cuts to US federal agencies that took effect in March and has no end in sight.

So it seems that the most important relationship in my life, the one I have put above all others — my love for academic research — is falling apart, owing in no small measure to circumstances beyond my control. As this happens, I think about all the time I have spent away from family and friends, and all the relationships that have fallen by the wayside as I moved from state to state to build my career.

Academia has been a difficult love. It seems to have made some promises it did not intend to keep, and no amount of torch-song singing will make the potential loss feel any less dire. I need to remember the refrain from Joni Mitchell's *A Case of You*: having drunk my fill of academia, I can still be on my feet. If my career comes to an end now, maybe I can keep my heart intact, and move on.

But until it comes to that, I will hold on to this love. Maybe, despite the chilly job climate and data delays, my career can still flourish. Why else would I have given up so much? I continue to submit papers and grant applications. I'm looking for postdoc posts or teaching positions that will keep me in the game until the tenure track comes courting. I'm throwing away my misgivings, refusing to become resigned to a life outside academia, and hoping beyond hope that this love is the one that will not leave me.

And if it does?

Well, I'll defer again to Joni: "If you want me I'll be in the bar …" ■

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