Home is where the bench is

International mobility is not restricted to young scientists

Expatriate scholars have a rich and long history. Take, for instance, the Goliards: priestly academicians who travelled throughout medieval Europe and pursued their studies. Unfortunately their proclivity to also chase wine, women and song meant that the Church put a stop to their wandering in the early fourteenth century. In contrast to the *joie de vivre* of the “monks and drunks”, Fascism and Nazism starting in the 1930s forced a number of top European scientists to emigrate to the USA, including Italian physicist Enrico Fermi (1901–1954) and German physicist Albert Einstein (1879–1955). After the Second World War, Operation Paperclip recruited German rocket scientists—notably Wernher von Braun (1912–1977)—to work on the US Army’s rocket development programme and, later on, NASA’s Apollo programme. Similarly, Russian intelligence agencies gathered German scientists to work on their missile projects.

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Today, a new generation of senior scientists is leaving their homelands for reasons that include political restrictions on research, mandatory retirement policies, frustration about government funding and the siren call of a booming Asian economy. US stem cell scientist Roger Pedersen, for example, formerly of the University of California, San Francisco (UCSF), left the turbulent US research environment in Autumn 2001 after the George W. Bush administration began to restrict stem cell research. He joined the University of Cambridge in the UK to conduct human embryonic stem

cell research in a new lab with government funding of £1 million.

Pedersen remembers the first clear signal that the Bush administration was serious about limiting his brand of research: “I still remember the day—it was April 12th. It was like a bolt out of the blue. Simply, an anonymous voice said, ‘we regret to inform you that your application for embryonic stem cell research funding has been administratively inactivated.’ And I said, ‘why?’ She said, ‘because of factors that we cannot discuss.’ And I said, ‘well, that doesn’t make any sense to me at all. Where is this coming from?’ And she said, ‘well, higher up. Higher up.’”

As a ‘researcher in exile’, Pedersen quickly became a *cause célèbre* when *The Wall Street Journal* used his case to illustrate the impact of President Bush’s announcement in August 2001 that federally funded scientists could only use the 60 extant human embryonic stem cell lines. As the *Journal* noted, the UK’s lighter regulation of stem cell research suddenly became extremely attractive for academics and corporations that were interested in developing new stem cell lines, as Pedersen’s relocation demonstrated (Naik, 2001).

Pedersen says that although he knows a few other researchers who have moved to the UK, his fellow expats are primarily those who work on mice and whose research was therefore never restricted in the USA. “There wasn’t a brain drain,” he said. “Not even the trickle, unless I was the trickle! I’ll probably be the only one.” However, he did comment that there has been a brain drain in stem cell research in general, as young scientists have changed direction in the light of Bush’s reforms. “Many people would not have the freedom or perhaps temerity to do what I did, and their careers and family circumstances wouldn’t permit it,” he said.

Pedersen, now 64, was able to leave San Francisco with relatively few family ties to

hold him back: “I left UCSF as an early retiree and moved [to the UK]. In order to do that, you’d have to be near retirement age and be willing to tolerate the consequences of an early retirement,” he commented.

Indeed, mandatory retirement is a powerful reason for some senior researchers to move on to new pastures. You might blame it on Bismarck. In response to pressure from the social democrats, Otto von Bismarck (1815–1898), the Chancellor of the German Empire, introduced old-age social insurance—the pension—in 1889. The insurance was intended to look after people aged 70 and above, but this threshold was later lowered to 65; an age rarely reached at the time.

These days, many people reach 65 and welcome retirement, but for some scientists, their passion for research is not dulled by time

These days, many people reach 65 and welcome retirement, but for some scientists, their passion for research is not dulled by time. Klaus Rajewsky, 72, is a German immunologist who is renowned for his work on B cells and for the development of conditional knockout mice. In 2001, he left the University of Cologne and headed to the USA—to Harvard University (Cambridge, MA)—to avoid mandatory retirement in Germany. His distaste for forced retirement dates back to the 1960s when his father, Boris, a pioneer in radiation biology, languished after his forced retirement from his position as director of the Max Planck Institute of Biophysics in Frankfurt. “My father suffered from a retirement problem. It was very unpleasant because he wanted to hang on [...] he just stayed in his office

in the institution and, in a certain sense, he was almost forced out of it. It was a very bad experience for him," Rajewsky said. "Everybody is forced to retire [but] I always thought I would avoid this by all means." He added that mandatory retirement was a common discussion among senior colleagues in Europe: "Everybody was constantly talking about this issue: what are we going to do after retirement. It's the most boring kind of conversation you can have; I mean, it's really terrible."

As a top scientist, Rajewski had some options open to him through which he could continue his research. He could have been a programme coordinator at the European Molecular Biology Laboratory (EMBL) in Monterotondo, Italy, where he had worked part-time since 1996. "I thought this would give me an opportunity to stay longer than as a university professor at the University of Cologne," he said, noting that the EMBL position would have extended his career for at least five years beyond the mandatory German retirement age. In addition, the University of Cologne also offered him a year-by-year extension of his contract, although the lack of security would have made it difficult to attract students and post-docs to his lab.

Rajewsky's departure—and those of some other senior German academics—has raised the profile of discussion about mandatory retirement in Germany

In the end, it was an offer from Harvard University to create a new professorship specifically for him that won Rajewski's enthusiasm: "It was really a liberating offer," he recalled, "because I received [...] a letter saying that I would be a professor at Harvard without limit of time. After a lot of deliberation, I decided to pack my things and go to Boston." In addition to saving him from retirement, Rajewsky noted that Harvard

has given him a renewed professional life: "There's a density of top scientists, which is basically non-existent anywhere else. So for me the move at this age was, in retrospect, something extremely refreshing, invigorating. I can only say positive things about this."

Rajewsky's departure—and those of some other senior German academics—has raised the profile of discussion about mandatory retirement in Germany. "One of the more positive results from [my departure] is the fact that German politicians began to discuss changes to the retirement rules [which] have been somewhat softened," Rajewski commented. Indeed, the situation in Germany is improving: when Theodor Hänsch, winner of the 2005 Nobel Prize in Physics and director of the Max Planck Institute of Quantum Optics in Munich, turned 65 in 2006, the Max Planck Society was able to retain him in his position with support from the Bavarian state, in spite of serious wooing by some US universities. In fact, despite author F. Scott Fitzgerald's observation that there are "no second acts for American lives," Rajewsky is contemplating a third act: "I'm considering moving back to Germany in a few years to continue to work," he said.

Davor Solter, 68, is already into his third act. As a respected scientist in the fields of stem cell research and developmental biology, the Croatian sexagenarian has been a citizen of the world—a professional expatriate—for nearly 40 years. "It sounds too romantic to be true," he said, "but in a sense, yes, it is." Solter, who holds MD and PhD degrees from the University of Zagreb in Croatia, worked in the USA in the 1970s and 1980s at The Wistar Institute in Philadelphia; at the Max Planck Institute of Immunobiology in Freiburg, Germany, in the 1990s; and since 2008, at the Agency for

Science, Technology and Research (A*STAR) Institute of Medical Biology in Singapore.

Solter said that his research on mouse stem cells was not affected by the battles over human stem cell research in Germany and that his decision to move to Asia was based on planning for his retirement. He explained that the changes made to the German retirement rules in the aftermath of the Rajewsky case mean that he could have remained as a Max Planck director until the age of 68, and could have continued his research until 75, but that this would not have worked out for him. The Max Planck rules allow junior group leaders to be hired for five years, after which time they must move on. As director, Solter would have reached the age of 68 and would have only been able to offer two-year contracts, which would not have been attractive to young researchers. "I certainly didn't see any point of trying to hire people to come for two years because another Max Planck rule is that when the director retires, his whole department and everything is dismantled," he explained.

Solter retired from his position at the Max Planck Institute in 2007, but both he and his wife—developmental biologist Barbara Knowles, former vice president for education/training and external scientific collaboration at The Jackson Laboratory in Bar Harbor, MN, USA—were attracted by the opportunities at Biopolis, Singapore's fast-growing research complex that has been luring senior scientists worldwide away from their home countries. Both Solter and Knowles are now senior principal investigators at A*STAR's Institute of Medical Biology

and are establishing a laboratory to study the reprogramming and differentiation of stem cells.

Solter said that Biopolis is a mixed expat society with scientists from many nationalities including British, French, Russian, Portuguese, Spanish, Italian Scandinavian and American. "People came for different reasons. But a major reason is the funding is secure. You don't have to write grants. Everybody agrees that working conditions are very good because Singapore is really committed to establishing a major scientific place," Solter explained. "There are probably between 500 and 1,000 independent senior scientists. In scientific terms, it's an excellent place." Indeed, Solter plans to finish his career in Singapore. "There are people who work and work and then one day they drop dead in the middle of the lab and that's it," he said. "I would rather not do that. But Singapore is definitely my last place."

It was the promise of a better climate that drove cancer geneticists Neal Copeland and Nancy Jenkins—a husband and wife team—to become two of the top 50 most-cited biomedical scientists to join A*STAR in 2006. It was not just the weather in Singapore that appealed to them, however. "The heat and humidity in the summer in Washington is much worse than in Singapore. In Singapore, the average high is 90–91 °F. And the average low at night is around 76–77 °F, 78 °F maybe. To me, that's perfect," Copeland said. Rather, it was the funding climate in the USA.

"Under the eight years of Bush, the money going into research went down in real dollars. All our friends were losing grants, even friends who were Nobel laureates"

Copeland, who is now the executive director of A*STAR's Institute of Molecular and Cell Biology (IMCB), explained that to make the move, they had to leave behind their long-time research base at the National Cancer Institute–Frederick (MD, USA). Both of them had held senior positions at the institute, but, as they approached retirement age, they became increasingly frustrated with the reduced levels of funding available for science during the Bush era. "I was 59 when we left and Nancy was 56," Copeland

said. "We were tenured at [the National Institutes of Health (NIH)]; we directed a big program. Things were good, but every year it got more depressing in the United States [...] Under the eight years of Bush, the money going into research went down in real dollars. All our friends were losing grants, even friends who were Nobel laureates. [...] When people left, we couldn't replace them."

Jenkins added that when they announced that they were looking to leave the NIH, they fielded offers from Stanford University (CA, USA) and Memorial Sloan–Kettering Cancer Center (New York, NY, USA). Despite this, the paucity of grants in the USA gave them pause for thought. Copeland explained that they would have faced a hard slog to raise the money needed to run a laboratory with thousands of cages of mice. "We were at NIH, and all the money came from the federal government. And the reason we stayed at NIH for so long was that we had huge amounts of money," he said. "If we went to Stanford, we were going to have to write ten grants to support our mice. We were going to spend our whole life writing grants." As such, the affluent research climate of Singapore beckoned.

Their long-time collaborator, cancer researcher Yoshi Ito, had joined the IMCB

when he was forced to retire in Japan at the age of 62. "He invited us to Singapore to give seminars," Copeland said. "One thing led to another and [the IMCB] made us offers. The attraction for us was [that all] the money to fund the research comes directly from the government. There are no grants [...] we could move here and still support our research [...] and [we could] get out of the NIH system and the American system into a place that seems to appreciate research and is investing heavily in research [...]"

Copeland and Jenkins relocated themselves and 100 strains of mice to Singapore and now plan to stay there. Copeland said that they visit the USA regularly and are concerned about the future of science there. "The system is broken, but President Obama is great. I think he's a good president and they're lucky to have him because he wants to put more money in science. But where is it going to come from?"

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How smart is smart?

Is human intelligence still evolving?

The development of higher cognitive functions in *Homo sapiens*—commonly and perhaps wrongly described as intelligence—preceded and enabled the rise of human civilization. Yet, although it has been an important factor for our social, cultural and technological evolution, intelligence itself remains an elusive concept. Molecular biologists, neurologists, psychologists and anthropologists have long-pursued the questions of how, why and when intelligence evolved, and have also been debating whether human intelligence will continue to evolve and, if so, where it could lead.

The challenge of investigating intelligence and understanding how it works begins with its definition and measurement.

Bob Sternberg, for instance, a psychologist from Tufts University (Medford, MA, USA) and a pioneer of human intelligence research, believes that intelligence is an adaptive trait, but not a quantity that can be measured by standard intelligence quotient (IQ) tests. Instead, he has defined human intelligence as "a mental activity directed toward purposive adaptation to, selection, and shaping of real-world environments relevant to one's life" (Sternberg, 1985). However, there is a caveat to this so-called 'triarchic' theory: its human devisers are not objective bystanders. "Higher levels of intelligence as we conceive of it can be and [have] been adaptive," Sternberg said. "I say 'as we conceive of it' because the concept [of intelligence] is in large part a human