The new geography of scientific collaborations

Changing patterns in the geography of science pose ethical challenges for collaborations between established and emerging scientific powers

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For at least the past decade, scientific research has seen an increasing trend towards international collaborations. Scientists have always been members of an international community, but new demands on research have further catalysed cooperation between institutions and countries. Many research questions are simply too large to be tackled by a single lab and require cross-discipline and cross-border cooperation. Moreover, collaboration also makes research more efficient through shared expertise, facilities and materials; collective funding is vital for complex research infrastructures—databases, particle accelerators, satellites or microscope facilities—that have become too expensive to be run by one institution or country alone. Consequently, international cooperation is the norm at all levels of research, from individual groups to whole countries.

Despite the obvious benefits of international research teams and networks of experts, cooperation also creates its own challenges and pitfalls. In extreme cases it can even hinder progress. Subra Suresh, Director of the US National Science Foundation, has stated that “the most fundamental barriers to bilateral and multilateral international collaborations are disparate standards for scientific merit review and differences in the infrastructures that ensure professional ethics and scientific integrity. These factors are further exacerbated by cultural differences that arise from the large range of social perspectives and stages of national development” [1]. In particular,

cultural differences lead to different interpretations of what constitutes responsible conduct of research (RCR) in many areas, from the conduct of research itself to animal welfare, biosecurity or the involvement of human subjects. These differences and their impact on research are particularly relevant for collaborations between established and emerging scientific powers and for changes in science policy within and among different countries [2].

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During the past two decades, the policies and dynamics of international collaborative research projects have profoundly changed, particularly in response to a greater awareness of research misconduct, notably fraud and falsification. In the 1980s, allegations of research misconduct and misappropriation of federal research funds drew the attention of the US House of Representatives [3,4]. In response, the US Government created the Office of Science and Technology Policy (OSTP) and the Office of Research Integrity at the National Institutes of Health. OSTP now defines research misconduct as fabrication, falsification and plagiarism (FFP) in proposing, performing or reviewing research,

or in reporting research results. This definition helped to set standards and highlighted the need for addressing research integrity and responsible conduct of research (RI/RCR) elsewhere. In fact, a growing number of countries have begun to address RI/RCR issues in their scientific, political and educational agendas. However, apart from flagrant cases of fraud and falsification, various countries and jurisdictions differ in what they consider acceptable and unacceptable conduct in research [5,6].

As such, there is a need to establish internationally agreed best practices and accountability in scientific research. In 2007, the First World Conference on Research Integrity produced a final report that made recommendations to “clarify, harmonize, and publicize standards for best practice and procedures for reporting improper conduct in research” and “to incorporate global standards for best practice and policies for responding to misbehaviour into training and research environments” [7]. In 2010, the Second World Conference published *The Singapore Statement on Research Integrity*, which recommends a global consensus on principles and responsibilities to define research integrity and accountability in the conduct of research [8]. The Second World Conference also explored how prominent cases of research misconduct and questionable research practices have led to new education and publication policies, which suggest a new *modus operandi* for carrying out and publishing research.

The growing international attention to misconduct has had a profound impact on definitions of authorship in scientific publishing [9]. These views have challenged assumptions that look at authorship as conceptually and ideologically fluid [10,11] and they drive current debates on the responsibility and accountability of authors in publication practices. Authorship decisions in research are influenced by unwritten norms and institutional traditions [12]; these norms have been increasingly affected by the pressure to publish in high-impact journals, and norms are not the same in the USA, Europe, Japan and China [13]. This is the case, for instance, with honorary authorship [13] or ghost-writing [14]. These divergent views on authorship attribution are also evident in definitions of research misconduct in various countries [5,9]. In Australia, for instance, authorship misattribution is considered misconduct, whereas in the USA and some European countries it is usually considered a 'questionable research practice' and is not subject to institutional sanctions [15].

Concomitant with the challenges to definitions of responsible conduct, research ethics and standards of authorship, a new pattern in the geography of scientific collaborations has begun to emerge. A recent report from the

Royal Society (London, UK) highlights the fact that Brazil, China, South Korea, India and nations in the Middle East are playing a growing role in the global research network, driven by common interests in climate change, water, food and energy security, population change and loss of biodiversity [16]. Traditionally recognized scientific powers, such as the USA, Japan and Germany, have both sought and accepted research partnerships with newcomers including China, India and Brazil. In Brazil, scientific activity is growing so fast that Brazilian science has been described as "riding a gusher" [17] and might soon be considered "a hot destination for seekers of science" [18].

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The Brazilian government has made large investments in science, technology and innovation, particularly in human capital. The Center for Strategic Studies and Management in Science, Technology and Innovation reports that from 1996 to 2008, the number of PhDs in Brazil grew in federal (416%), state (396%) and private institutions

(170%) [19]. In 2008, there were 132,000 PhDs in Brazil, equivalent to 0.14% of the Brazilian population between 25 and 64 years old. As part of a new exchange programme called 'Science Without Borders', launched by the Ministries of Science and Education in 2011, Brazilian students and postdocs are signing up for international collaborative activities in 330 institutions in the USA, Canada, Europe, Japan, South Korea, China and other established or emerging scientific powers [20]. In this diverse network, universities in the USA and in the European Union (EU) account for the greatest number of proposed host institutions.

Given the increasing collaboration between non-traditional players, whose approach to RI/RCR issues is still maturing, it will be important to establish training programmes so that partners might have a better understanding of each others' perceptions of research ethics and integrity. Developing China–Brazil, UK–Brazil and USA–Brazil RI/RCR training programmes, for example, would be in line with the recent USA–China Consultation on People to People Exchange (CPE) [21]. CPE is a cooperation agreement that aims, among other goals, to strengthen relationships between young scientists from both the USA and China, foster innovation and pursue common interests in science and technology. Activities focusing on research integrity are incorporated in these exchanges.

Addressing differences in ethical standards is clearly an important part of scientific cooperation programmes [2]. It is an issue of increasing concern in the Organization for Economic Co-operation and Development (OECD) countries; in 2007, the OECD set up a committee to formulate practical guidelines for dealing with misconduct allegations in international collaborative projects [22].

Plagiarism is a case in point. Case studies frequently illustrate different cultural perceptions about plagiarism and about the level of tolerance towards this practice in scientific publications [23,24]. Interpretations of authorship, intellectual property, moral rights, authority and disciplinary traditions are notoriously subject to variation across cultures [25]. In addition to these factors, plagiarism might reflect notions that scientists from Anglophone countries have a competitive advantage, given their better mastery of the *lingua franca* of science [26,27]. In the current scenario of international collaborations, diverse views of authorship, credit and plagiarism might lead to misunderstandings that will not always be easy to resolve.

Accordingly, the past few years have increasingly shown that researchers from China, Turkey and India—all emerging scientific powers—are prone to underestimating the importance of words in the communication of science [28,29]. In Brazil, it seems that a tendency to focus primarily on avoiding misappropriation of results and ideas rather than of language and descriptive tools might mean that some instances of plagiarism are overlooked [30], but there is still a lack of quantitative data on this issue.

As plagiarism in science is considered one of the major sources of conflict among authors from different cultural backgrounds, a national survey on plagiarism, self-plagiarism and redundancy will be launched this year in Brazil. This survey has the support of CNPq, which has established a Commission on Research Integrity, whose recent report on 'Ethics and Integrity in Scientific Practice' [31] uses the most common definition of misconduct, that is, FFP, but includes self-plagiarism. The national survey will contact all Brazilian PhDs registered in the CNPq database. One of the aims is to record trends among different disciplines, and to identify culturally sensitive factors that might serve to inform national,

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and possibly international, RI/RCR training programmes for young researchers. Training programmes for federally funded researchers and others are now common at universities in the USA and Europe, but most of them focus on topics such as responsible authorship, plagiarism, data management and research misconduct [32,33]. They reflect the need for establishing minimum standards to conduct and publish research, but many of them do not try to deal with culturally specific perceptions of RCR issues such as those that lead to different views of plagiarism.

We predict that Brazil, China, India and other emerging countries will begin to play a more important role in the ethics melting pot, which is just heating up. Identifying potential sources of conflict and implementing culturally sensitive RI/RCR training activities as part of international cooperation programmes are important goals. These combined strategies are clearly prerequisites for meeting the ethical challenges posed by the new geography of scientific collaborations. Universities in established and emerging scientific powers will need to take the lead in developing such strategies. These initiatives can both foster research excellence and better prepare the young generation of scientists to take full advantage of cross-cultural research collaborations.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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EMBO reports (2012) **13**, 404–407; published online 10 April 2012; doi:10.1038/embor.2012.51

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