

Monkey Business? Development, Influence, and Ethics of Potentially Dual-Use Brain Science on the World Stage

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At the recent annual meeting of the International Neuroethics Society, Dr. Mu-Ming Poo, of the China Brain Science Project, provided an overview of the proposed future directions and goals of neuroscientific research in China [1]. Through concentrated efforts of the Institute of Neuroscience of the Chinese Academy of Science (CAS), China is rapidly developing increasingly greater scientific and technological capability – and global prominence – in brain research. Poo emphasized the strong translational focus of such research in light of recognized epidemiological trends in neurological disorders. Underlying the importance of a better

understanding of these diseases, he said, is the fact that 1 in 5 Chinese citizens are likely to be affected by a neurological disease in their lifetime [1].

Critical to such progress in brain sciences has been the emphasis upon (and directed support of) biomedical research and development (R/D) in China's 12th and 13th national Five Year Plans (FYP). Of seven strategic industries supported by the 12th FYP, four were directly focal to advancing brain science (i.e. - biology, information technologies, high-end equipment manufacturing, and new materials) [2]. Approximately 14 trillion RMB (2.16 trillion USD) has been dedicated to foster, execute, and sustain initiatives that will drive these industries over the next 60 calendar months, so as to rapidly establish China's presence and influence in the field [3]. Chinese investors have also recently begun to invest in R/D opportunities in the United States. Since 1990, \$3.2 billion of China's direct investment in the United States has been directed toward health products, pharmaceuticals, and biotechnology [4]. In August 2016, a subsidiary of Greenland Holding Group, a Shanghai real estate development firm, announced its intentions to purchase a 42-acre property in San Francisco to initiate a \$1 billion project to build a 2.25 million square foot research center [5]. Most recently, in December 2016, Harbour BioMed, a Shanghai biotechnology company, acquired Netherlands-headquartered, Massachusetts-based Harbour Antibodies BV in an effort to establish a global biotechnology company [6]. According to press releases, Harbour BioMed's investors, Advantech Capital and Legend Capital, two China-focused investors with particular emphasis on life sciences, financed this

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acquisition [7, 8]. Chinese investment in other countries is also burgeoning: China has invested more than \$15 billion in FDI in Israel over the past four years [3].

Important to supporting these efforts has been a transition to an economic growth model that is based in large part upon entrepreneurship and production services. Dr. Poo further spoke to efforts of the Chinese government to ensure the infrastructure and financial assets necessary to attract both domestic and international scientists. Such infrastructural and economic development reflects defined political goals to leverage science and technology to exert strategic influence in international markets. The 13th FYP explicitly established policies to enable research institutions to exercise greater freedom in the use and solicitation of funds (inclusive of international commercial investments and purchases), directed the development of “innovation services,” and emphasized research as means to evoke and capitalize upon “subversive technological breakthroughs” [9, 10]. Dr. Poo explicated that China’s regulation of non-human primate (NHP; i.e. - marmoset and macaque) research is less defined and stringent than those of many western countries, including the United States. This, Poo expects, may serve to attract international neuroscientists, as it will enable them to conduct research using animal models that more closely resemble humans, without the ethical prohibitions currently in place in the United States and a number of other western countries.

What does this mean for the future of neuroscientific research and its applications? Of course, it could defensibly be argued that in its reliance upon Confucian philosophy and communitarian social values, Chinese biomedical ethics differs from a number of core principles foundational to western ethics. Yet, there have been recent assertions by Chinese scientists to the contrary [11, 12]. But given that current proscriptions on the use of NHPs reflect moral regard that is derived from and based upon information generated in and by neuroscientific studies, perhaps a more fundamental question is what does such a stance toward NHPs infer about the way (s) that China views and will use the knowledge and tools of brain science? And furthermore, what effect might this have on a broader, international scale? Clearly neuroscience and its technologies – and the institutions that generate and promulgate these enterprises – can exert strong influence in and upon international economic markets. Will the availability of NHPs and

influx of funds divert research to China and away from other countries? And what if such research results in products that have definitive value in global medical or public markets for neuroscientific techniques and technologies? Will such resources redefine medical treatments and the availability and use of direct-to-consumer neurotechnology products? Or, will such developments be shunned in light of what is considered to be ethical improbity in the use of NHPs? Certainly, this is important to consider – and be prepared for – both as regards China’s efforts, and the research and use agendas, and ethical and regulatory postures of other countries that could gain appreciable benefit from such neuroscientific techniques, tools, and findings.

Attracting international neuroscientists to work on NHP models of brain disease and injury could easily increase resources from which effects on humans could be extrapolated and/or derived, and Dr. Poo was adamant about the medical benefits such studies could incur [1]. Of course, there is an economic value proposition to attracting international scientific talent and resources through the offering of NHP research. But this also raises concerns about tacit capabilities [13], and the yoking of NHP studies and findings to military agendas under programs of dual- or direct-use. The CAS and the Ministry of Science and Technology have supported dual-use and military research for the Chinese government, and a number of Chinese military medical centers are engaged in neuroscientific research, including the Fourth Military Medical University in Xi’an, the Third Military Medical University in Chongqing, and Southern Medical University (formerly First Military Medical University) [14–17]. Of particular note in such efforts is *Junweikejiwei*, the newly developed Chinese research agency that conjoins efforts of the CAS and China’s Ministry of Defense, and which is modeled after the United States’ Defense Advanced Research Projects Agency (DARPA), to engage rapid, high-risk/high-return approaches to bioscience and technology [18].

To be sure, such endeavors are not unique to China, as many countries, including the United States, engage in brain research that is applicable to, and employed for national security [18–20].¹ However, the direct involvement of the Chinese government in all aspects of

¹ Although there have been calls to restrict if not prevent military use of neuroscientific research [see, for example, ref. 21], and academic research for military purposes is proscribed in certain countries (e.g. - Germany).

academia and industry makes the exchange of information and tools that can be used for military agendas almost seamless. Moreover, the development of neuroscientific techniques and technologies in and for the health care sector easily can - and often is intentionally developed to - “spill over” into national defense initiatives [19–22, 23–28]. Particularly thorny in this regard are those instances where research is protected by intellectual property rights and/or does not fall neatly under current DURC stipulations, or Biological Toxin and Weapons (BTWC) or Chemical Weapons Conventions (CWC) [19–22, 23–26]. This can make it difficult to ascertain the intent of specific programs and projects, and what constitutes dual-use research of concern (DURC) - both to those scientists who may be engaged in them, and to international regulatory agencies.

It is becoming clear that China’s policies and activities are aimed at advancing its potential to leverage science, technology, ethics, policy and law to fortify domestic biomedical capability, and to exert international influence in healthcare, economic, political, and military domains [19–22, 23, 24]. This can, and likely will foster collaboration, and in certain instances, competitiveness. In this light, it becomes important to ask what this portends for the future applications, economics, ethics, oversight and regulation of neuroscience; not only in China, but worldwide. As with any research enterprise and set of practices, it is important to examine methods, (explicit, implicit, and possible) uses, and consequences that can be incurred. Therefore, if neuroethical address and analyses are to authentically inform international guidelines and policies that direct the sound conduct and use of brain science [29, 30], then veracity, veridicality, and clarity in the discourses and activities of neuroscience *and* neuroethics will be ever more essential- regardless of where they occur.

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