

In the light of these examples, which I had to expose briefly for lack of space, it seems that big teams directing research in a single direction with the greatest number of funds and resources might not always be the best solution—either for science or for society. ■

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Go Big or Go Home: Big Science and ELSI Funding

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In their article on the European Commission's nearly ill-fated Human Brain Project (HBP), and the concomitant United States BRAIN (Brain Research through Advancing Innovative Neurotechnologies) Initiative, Christen and colleagues (2016) describe the potential ethical consequences and significances of these representative efforts in Big Science brain research. In particular, Christen and colleagues remind the readers that there are many justifications for Big Science projects, including the knowledge generation that comes from broad, multifaceted, and structured collaborations across disciplines and continents.

These Big Science neuroscience projects are often compared to other arguably successful large-scale endeavors in other fields of science, including the Manhattan Project, CERN (The European Organization for Nuclear Research, derived from its name, Conseil Européen pour la

Recherche Nucléaire), and the Human Genome Project (HGP). And although metaphors associated with the goals of the Human Genome Project, such as the idea of mapping the heretofore unknown, have also been associated with the desired endpoint of these neuroscience projects (i.e., the Connectome), detractors of HBP often contrast the arguably very defined goals of these former projects with what they perceive to be poorly defined goals of the neuroscience project (Frégnac and Laurent 2014).

These neuroscience projects also hope to replicate some of the nonscientific albeit successful efforts of the Human Genome Project, including the development of an open, data-sharing culture, buoyed by institutional standards and norms, particularly in light of the expense of generating neurological data. These data-sharing norms often come to fruition as a necessary prerequisite

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in developing large-scale scientific projects (Choudhury et al. 2014).

Another area that the neuroscience projects hope to emulate is the institutionalization of the analysis of the ethical, legal, and social implications (ELSI) of the proposed neuroscience research (The HBP Report 2012). Given their focus on ethics, it is notable that Christen and colleagues leave out the development of this formalized ELSI system in their analysis of Big Science, particularly as typically such programs can only arise out of these large Big Science projects.

HBP's express interest in emulating ELSI perhaps reflects a promising future for ELSI endeavors. This is good news. Around a decade ago, the field of bioethics seems to have had a crisis of confidence. In particular, there were a number of articles especially concerned with the field's perceived conflicts of interest and lack of scholarly independence (Sharp et al. 2008; Sharpe 2002). As in bioethics, there are also many critics of the field of ELSI (Morrissey and Walker 2012), a direct outgrowth of the bioethics field, and a discipline explicitly tied to government-funded research programs (Green, Watson, and Collins 2015).

Modern ELSI can trace its roots to a purportedly unscripted remark by James Watson—then head of the U.S. effort in the Human Genome Project—that assigned a percentage (initially 3%, eventually 5%) of the project's substantial research funds toward the analysis of the ethical, social, and legal aspects of the groundbreaking genomics project (Greenbaum 2015). This seemingly off-the-cuff remark has resulted in hundreds of millions of dollars in funding over the past quarter century for ELSI research, albeit most still tied to large genomics projects.

BIG SCIENCE/CONSORTIA SCIENCE

Corresponding to the aforementioned concerns in bioethics, this continued direct connection to Big Science consortia has been a source of consternation for some: Critics have argued that tie-ins to large consortia research projects, such as the HGP, relegate ELSI researchers to simply yes-men, whose sole purpose is to provide a patina of oversight, and who lack the financial independence to question the underlying foundations of the research efforts, or to conduct their own independent research efforts (Epstein 2008). Nevertheless, in spite of their clear dependency on the largesse of Big Science, the ELSI field has possibly gained substantially by being part of these large consortia, and has much to benefit from the continuation of the trend to develop Big Science consortia.

Arguably, ELSI could not survive in its present form without consortia backing, both financial and institutional. ELSI researchers often come from diverse academic fields, with some seeking to re-career, but most drawn together by shared interests and available funding. These ELSI academics further benefit from broad interactions with all relevant stakeholders, from scientists to policymaking lawyers, exchanges made possible by the large scale of

these Big Science efforts. Moreover, these interactions might not be possible, or as forthcoming, with ELSI investigators siloed into their own independently funded and unrelated fiefdoms.

Still, there are some who consider the boundaries of consortia sciences as too constrictive for ELSI research. They argue that just as small science efforts can be squelched by big science efforts, similarly consortia-aligned ELSI forces an extreme-centrism on the researchers at the expense of heterogeneous methods and insights (Dove and Özdemir 2015), gravitating toward trivial questions rather than the more foundational, and focusing on facilitating, rather than critically assessing basic science research efforts (Myskja, Nydal, and Myhr 2014).

To some degree, the fact that much of the ELSI research is directly tied to concomitant scientific research may limit the expansion of the field, as researchers typically cannot find the funding to go off on their own. However, this system also creates multidisciplinary "research SWAT teams" with real experience in efforts in shaping policy and guiding research in light of ethical social and legal concerns (Oliver and McGuire 2011).

ELSI ASSOCIATED WITH CONSORTIA SCIENCE MAY BE MORE PRACTICAL

These policy and education efforts are often paramount. Unlike much of classical bioethics, large consortia ELSI naturally trends more toward the practical implications of scientific research, often with the goal of providing pertinent research and relevant commentary regarding the extrascientific concerns of a particular area of scientific research. Working with the consortia of Big Science, ELSI researchers are often more able than their social science peers to be practical, providing prescriptive real-time analysis, and, for example, providing for the identification of downstream contentious issues before an overly zealous implementation of the science becomes particularly problematic (Walker and Morrissey 2014). Some have suggested that the Genetic Information Nondiscrimination Act of 2008 (GINA), which prohibits genetic-based discrimination by employers and health insurers, is a direct outgrowth of ELSI research in the area of genomic privacy (Shen 2013).

Further, as part of these larger consortia, ELSI researchers also benefit from being able to directly interact with the scientists, or may actually be basic-science scientists on a second career. In this sense, ELSI researchers gain by being embedded in the trenches with the scientists themselves, rather than in the remote echo chamber of the ivory tower.

The narrow focus of many basic science researchers often results in an environment that promotes permissionless innovation: Without greater context for their research, many scientists don't appreciate, or care to appreciate, the ethical, legal, and social impact of their research. As such, consortia scientists also benefit substantially from this

sometimes forced interaction with researchers in the humanities, particularly researchers in fields that they might otherwise avoid, perceiving them to be too squishy (McEwen et al. 2014). To some degree this has been addressed by the introduction of obligatory ELSI components within many genomics grants.

CONCLUSIONS

Overall, ELSI is good for large-scale research efforts, particularly if the analysis is started at the earliest stages of the research, if for no other reason than to simply develop a public trust in the scientific endeavor through a clearly integrated and practical-minded ethics and policy program, and a directed effort to facilitate the public's understanding of the science. And Big Science is good for ELSI, as it provides a pragmatic grounding for the social science research, and funding that might not otherwise be available through national funding foundations. It also provides a framework for bringing together individuals with diverse backgrounds with the goal of examining a specific set of legal ethical and/or social issues. And finally, as an integrated component of the scientific research, ELSI researchers do not simply follow up after the problems have been created and try to clean up the mess, but rather, they have the opportunity to work alongside innovation, potentially providing criticism and direction to avoid making the mess in the first place. While ELSI research has heretofore been mainly in the field of consortia genetics, many areas of basic and applied science would benefit from the greater introduction of ELSI analysis, including, for example, synthetic biology, stem-cell research, and nanotechnology or neuroscience. However, replicating the success of HGP ELSI would likely not be possible outside of the consortia framework. ■

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