

EMERGING TECHNOLOGIES FOR NEUROSCIENCE: Building the New Brain Science

Kavli Futures Symposium Proposal

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The 21st C has been hailed as the “Century of Biology”, launched with stunning advances such as the mapping of the human genome¹. Among the goals that the scientific community has laid out are to understand the human mind from the genomic and cellular levels to the systems and cognitive levels, and importantly, to link these levels of explanation, not merely study them in parallel.

In 2013, President Obama announced a grand scientific challenge for understanding the brain; the BRAIN Initiative (Brain Research through Advancing Innovative Neurotechnologies), supported by the NIH, NSF, DOD and FDA, as well as private foundations, and individual states (e.g., California’s Cal-BRAIN plan). The initiative aims to identify the specific circuits and cellular and circuit mechanisms supporting behavior and cognition, in order to both understand the brain and mind, and provide the basic science knowledge necessary to cure psychiatric and neurological disorders. A key component of the BRAIN Initiative is to accelerate the development of new technologies for neuroscience research, in order to provide the tools to measure and manipulate neurons and brain circuits with a resolution (temporal and spatial) not currently available. In essence, the BRAIN Initiative, and related challenges, compels us to build a *new brain science*.

A New Brain Science: The *new* brain science may resemble some of the *old* brain science in that for decades neuroscientists have collaborated with engineers, mathematicians, psychologists and others to utilize new methods and technologies to study the brain. For example, a neuroscience graduate student in 1985 could only dream of the ability to investigate the living human brain using functional brain imaging. Today, however, virtually every neuroscience graduate student has the opportunity to do sophisticated structural and functional human brain imaging as part of their dissertation research. But much of the develop of tools such as functional magnetic resonance imaging (fMRI) were enabled by the development of new tools for clinical practice, not for brain science *per se*². The BRAIN Initiative calls for a more directed approach that provides support specifically to develop new technologies for basic science. In order for a new brain science to emerge such that interdisciplinary collaborations drive new technologies and approaches, rather than simply capitalizing on them when they are developed for other reasons, it will be important to build a new interdisciplinary community of scholars that brings behavioral, biological, physical/mathematical and engineering scientists together as never before³.

A New Community of Brain Scientists: Over the past 25 years, the Summer Institute in Cognitive Neuroscience, which has been supported by the McDonnell Foundation, NIDA and NIMH, built a new community of scholars that is now the field of cognitive neuroscience. Bringing together psychologists, linguists and cognitive scientists with neuroscientists and medical scientists, the field of cognitive neuroscience is now well

established. A new brain science needs to do this once again to create an expanded community that brings together cognitive neuroscientists with physical, mathematical and engineering scientists to create a new scholarly community that is capable of pursuing the lofty and exciting goals of the BRAIN Initiative and related efforts. This effort must directly incorporate areas such as informatics, biophotonics, nanotechnology, genomics, and must draw in the physical sciences as part of the new community of brain scientists.

The Kavli Futures Symposium: We propose to utilize the remarkable platform of the Summer Institute in Cognitive Neuroscience to begin to build this new community of brain scientists, by conducting a two-day symposium in the midst of the 2015 Summer Institute that would (tentatively) be titled, “Emerging Technologies for Neuroscience: Building the New Brain Science”. The symposium would be held between the two weeks of the Summer Institute, and would include some of the Summer Institute faculty already in Santa Barbara for the institute, and additional physical and engineering scientists to lay the groundwork for building the envisioned new brain science. Those international leaders already participating in the Summer Institute that would participate include: Brian Wandell (Stanford); Susan Bookheimer (UCLA); Michael Gazzaniga (UCSB); Robert Knight (Berkeley); Bill Newsome (Stanford). In addition, we will invite a list of experts from neuroscience, computational, engineering and physical science to fill out the symposium, including scholars like nanomaterial scientists Ruxandra Vidu (UC Davis) and Ioan Opris (Wake Forest)⁴, bioengineer Paul Sajda (Columbia)⁵, electrical and systems engineer/computational scientist Danielle Basset (Univ. of Pennsylvania)⁶, as well as imaging experts and theoretical neuroscientists Olaf Sporns (Indiana Univ.)⁷, Karl Friston (Univ. College, London)⁸, Terry Sejnowski (Salk Institute)⁹, Bruno Olshausen (Redwood Center for Theoretical Neuroscience/Berkeley)¹⁰, Karl Deisseroth (Stanford)¹¹, and others to be named.

In order to generate the maximal impact in creating the new community of scholars, we will invite the 70 Summer Institute Fellows (doctoral students and postdocs) to attend the symposium. Additionally, taking a further concrete step forward, for the 2015 Summer Institute, we will reserve 10 slots specifically for fellows coming from outside the usual cohort of cognitive neuroscientists, bringing in at least 10 fellows from mathematical, physical and engineering sciences. Therefore, the 2015 Summer Institute in Cognitive Neuroscience and the proposed Kavli Futures Symposium will be the first step toward building the new community of brain scientists that will, as their generation emerges, become the architects of the new brain science. In order to take these next steps we need additional support from private foundation sources that are more attuned to risk-taking at the frontiers of discovery.

Budget: An estimated budget for the symposium is \$50,000. This will permit us to bring in national and international scholars of renown to participate in the symposium, and will offset the additional costs of supporting the Summer Institute Fellows’ participation.

Thank you for considering this proposal.

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