Neuron
NeuroView

Australian Brain Alliance

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http://dx.doi.org/10.1016/j.neuron.2016.10.038

A proposal for an Australian Brain Initiative (ABI) is under development by members of the Australian Brain Alliance. Here we discuss the goals of the ABI, its areas of research focus, its context in the Australian research setting, and its necessity for ensuring continued success for Australian brain research.

History and Purpose

The Australian Brain Alliance (ABA) is an initiative of the Australian Academy of Science with a vision to coordinate and boost strategic brain research across Australia. The goal is to lead paradigm-changing research into the brain and its disorders, in collaboration with global brain initiatives. Since its establishment in February 2016, the ABA has successfully united researchers across the breadth of Australia's neuroscience and behavioral science communities, with early involvement of both the Australasian Neuroscience Society and the Australian Psychological Society, and the support of over 28 member organizations engaged in brain research. This alliance has developed an integrative brain research agenda that builds on Australia's strengths, with the aim of revolutionizing our understanding of the brain through a coordinated and collective effort.

The ABA's vision is to create a program with broad appeal by ensuring that research and infrastructure are developed in conjunction with government, funding agencies, industry, and philanthropic organizations. The goal is to secure investment in an Australian Brain Initiative (ABI), with a mission of creating an innovative and healthy nation by cracking the brain's code.

Cracking the Brain's Code

The overarching goal of the ABI is to "crack the brain's code." This is defined as understanding the mechanisms or "codes" that underlie how neural circuitry develops, how it encodes and retrieves information, how it underpins complex behaviors, and how it adapts to external and internal changes (see Figure 1). Discoveries in each of these areas will be essential for successfully achieving the following four grand challenges, which lie at the heart of the initiative:

(1) To optimize and restore healthy brain function throughout life,
(2) To develop neural interfaces to record and control brain activity to restore function,
(3) To understand the neural basis of learning across the lifespan, and
(4) To deliver new insights into brain-inspired computing.

As other brain initiatives have recognized, brain science is still in a discovery phase whereby understanding basic nervous system structure and function is a crucial precursor to delivering meaningful outcomes. Increasingly, it is being realized that investment in basic research, both technological and experimental, is essential for the discovery of innovative solutions in areas such as health, education, and 21st century industries (Kosik et al., 2016). However, the widely acknowledged "valley of death" in translation is testament to the fact that basic research alone is not enough. While Australia's recent record in moving from discovery to application is poor (Watt, 2015), we have demonstrated successes in a number of disciplines, including in the convergence of basic neuroscience with engineering (see Playing to Our Strengths, below). This is an area of focus for the ABI and one that the ABA believes can play a key role in Australia's future prosperity.

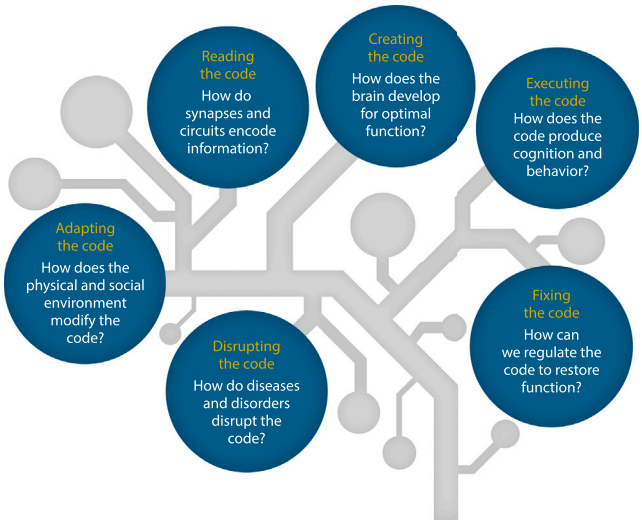

Figure 1. Cracking the Brain's Code

How Will the ABA Deliver Its Vision?

To facilitate the translation of fundamental science into practical outcomes, we propose a new approach that incentivizes and enables a collaborative discovery process between industry, universities, and other research institutions. Specifically, we suggest that dedicated, multidisciplinary science incubators be set up to facilitate linkage between discovery and industry. The expectation is that this will lead to a pipeline of applications that stem from the foundations of blue-sky brain research.

This approach will enable new and existing companies to capitalize on the work of the ABI as well as other large-scale brain initiatives, which are united in their aspiration for discoveries that will help crack the brain's code. The results will drive innovation in developing new devices, diagnostic methods, and

interventions for health and education, and spur the establishment of new industries (Figure 2).

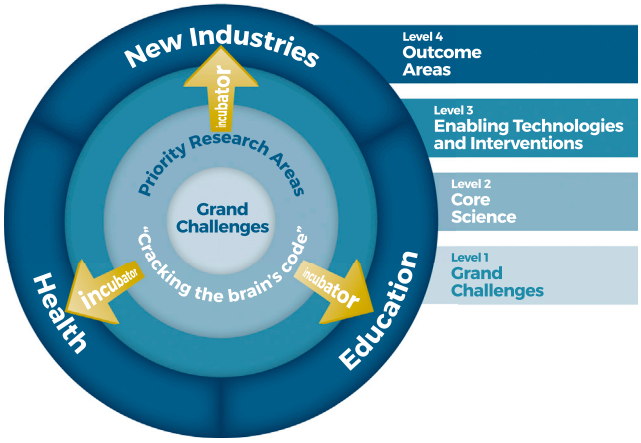

Figure 2. Conceptual Diagram Illustrating the Proposed Structure of the Australian Brain Initiative

Playing to Our Strengths

For a country of its size—just 24 million people—Australia has a strong history in neuroscience and neurotechnology. In 1948, John Cade discovered the therapeutic efficacy of lithium in treating bipolar disorder, a drug that remains the treatment of choice for this patient population. In 1963, John Eccles shared the Nobel Prize for work on the ionic mechanisms of neuronal inhibition and excitation at the Australian National University. In 1978, Graeme Clark's research at the University of Melbourne led to the first successful cochlear implant and to the founding in 1981 of Cochlear Limited, a company that Forbes magazine named one of the world's most innovative companies in 2011. In 1983, Alan Finkel—now Australia's Chief Scientist—founded Axon Instruments (subsequently bought by Molecular Devices) to commercialize devices he developed for making high-resolution electrical recordings from neurons. More recently, a start-up company, Saluda Medical, founded by ex-Cochlear scientist John Parker, has developed a closed-loop spinal cord implant for chronic pain management (Crow, 2016). The device, currently in clinical trials, has the potential to change the lives of the 1 in 5 people who experience chronic pain.

Australian psychologists have also made significant advances in our understanding of cognition and behavior. Several national centers have been established with the goal of understanding a range of cognitive processes—including attention, learning and memory, language and reading, and decision making—as well as the neural circuitry that regulates these processes. Researchers in these centers have highlighted the key role of attention in the encoding of new information and the importance of computational modeling approaches for understanding simple and complex behavior. The outcomes of this work are already being felt in the community. For example, Australian expertise in models of complex processes in reading have contributed to education through the new National School Curriculum.

Capabilities in the genomic analysis of patients with neurological and mental illnesses and access to well-characterized cohorts of participants are also areas of research strength in Australia. For example, twin and family studies led by Sam Berkovic and Ingrid Scheffer at the University of Melbourne, utilizing the Australian Twin Registry, have revolutionized our understanding of the genetic basis underlying many forms of epilepsy (Vadlamudi et al., 2014). In addition, Australia possesses a well-organized and established infrastructure for longitudinal analysis of health data, with a number of unique cohort-based programs allowing genetic, epigenetic, and other biomarkers of health and disease to be measured over an individual's lifetime.

Our capacities in these fields have helped guide the areas of focus for the ABI. In many ways, they are complementary to brain initiatives in progress, or in development, in the U.S., Europe, Japan, China, Canada, and other countries (see this issue of *Neuron*).

Why Does Australia Need the ABI?

Australian brain researchers lead internationally competitive research programs across many areas of neuroscience such as brain development, the aging brain, neurogenetics, and the physiological processes of brain and nervous system function. The ABI aims to build on this expertise while facilitating creative new approaches to understanding brain function. Deciphering how the brain encodes, retrieves, and utilizes information is essential for the development of novel treatments and interventions for brain disorders. In addition, it will enable advances in neurotechnology and brain-inspired computing.

Achieving these goals will require the merging of historically distinct scientific disciplines such as engineering, chemistry, physics, and computer science with neuroscience and psychology in so-called "convergence science" (Sharp et al., 2016). Currently, science is funded in Australia through small, individual investigator project grants or through multi-investigator Program and Centre grants that are divided into either medical research (funded by the National Health and Medical Research Council) or non-medical research (funded by the Australian Research Council). The ABA proposes to transform the Australian brain research landscape by establishing a framework to bring together existing brain researchers and scientists from other disciplines to "crack the brain's code." This will require alternate funding models in which discipline barriers are broken down, and which can accommodate the scale of the initiative being proposed. In this way, the ABI will complement rather than replace the current government-funded activities in brain research.

The ABI must ensure that its proposed brain research agenda is aligned with the Australian Government's focus on ensuring industry and public good outcomes from research. Indeed, the challenge of achieving a significant publicly funded research initiative at a time of fiscal restraint provided the impetus for the ABA to step up and demonstrate how brain science can help grow the Australian economy. A major goal of the ABI is

Box 1. Summary of the Australian Brain Alliance

GOVERNANCE

The Australian Brain Alliance (ABA) is led by a steering committee comprised of Australia's leading neuroscientists and psychologists, chaired by Emeritus Professor Patricia Michie.

HISTORY

The ABA was established in February 2016 under the auspices of the Australian Academy of Science with founding members including the Academy's National Committee on Brain and Mind and the peak bodies of the Australasian Neuroscience Society and the Australian Psychological Society. Since its inception, the ABA has grown to include 28 member organizations, including most major Australian universities and research institutes engaged in brain research.

MISSION AND SCOPE

The ABA has proposed the establishment of an Australian Brain Initiative (ABI), a transformative brain research agenda aimed at coordinating Australia's existing brain researchers and scientists from other disciplines with the aim of "cracking the brain's code." With an integrative convergence science research agenda, alongside a novel translational framework, the ABA expects the proposed ABI to make significant advances toward optimizing and restoring brain function, developing advanced neural interfaces, understanding the neural basis of learning across the lifespan, and developing new insights for brain-inspired computing.

FUNDING

The ABA will work with government, industry, and philanthropic organizations to secure cooperative funding for the proposed Australian Brain Initiative.

FIND OUT MORE

For more information visit http://www.ausbrain.org.au or contact kaori.ikeda@science.org.au.

therefore to ensure that discoveries in the brain and behavioral sciences form the foundation for improving health and education, stimulating new industries, and creating new jobs.

To achieve these objectives, we believe the ABI must provide not only the knowledge, but also the organizational structures for generating new industries and treatments for brain disease. In concrete terms this will involve directing new funding to key priority-driven research areas (see Figure 1) and incubator-like facilities to link research and industry. Critically, it will also mean retaining and building the Australian brain research workforce through education and training infrastructure. This will occur in part through targeted fellowships that already exist in Australia, but also through new training grants in convergence neuroscience. The ABA will also prioritize engagement with the international brain research community, public outreach, and policy initiatives that address the rapidly moving field of neuroethics (Farah, 2015).

A Roadmap for Success

Global brain initiatives aim to understand the neural basis of cognition and brain function, enabling better diagnosis and treatment of brain diseases. These are lofty goals. Brain scientists must address these issues by developing research strategies that prepare the public and governments for what can be achieved in the short-to-medium term. It is important to communicate to our stakeholders about our aspirational goals but also those goals that will create impact in the short term.

For example, one identified grand challenge of the ABA is to understand the neural basis of learning to provide better education and learning outcomes across the lifespan. We chose learning because it will have profound outcomes for the Australian community and will lead to a greater understanding of brain function in other domains. It is now well established that the aging population will require better ways of maintaining a healthy brain for as long as possible, which would reduce the impact of dementia and lead to major economic benefits. A definition of a healthy brain is one in which the person has the capacity and motivation to learn and apply new information. This goal is perfectly compatible with ways of understanding and optimizing how the brain learns in childhood and can be adapted for every stage of life to promote healthy brain function. A deeper understanding of how the brain learns, retains, and retrieves information will also stimulate improvements in brain-inspired computing. It is for these reasons that the ABA has singled out learning as one of the research grand challenges. A specific goal is to develop an evidence-based online learning assessment for each stage of life that measures and characterizes a person's learning strengths and abilities on an individual basis. This would be the

first step in identifying areas with the most potential for improvement and therefore areas to target for intervention, resulting in significant economic and health benefits.

The Future

In April 2017, the ABA will hold a conference and a series of workshops at the Australian Academy of Science in Canberra, the nation's capital. The objective of the conference is to present and discuss the ABI with the science community, government, and public and to offer an opportunity for further broad input into the ABI research agenda.

The essential next steps for the development of the ABI are:

(1) To identify suitable goals for the ABI with defined end-points,
(2) To engage potential industry partners in the ABI,
(3) To develop a research strategy that responds to the needs of the community, and
(4) To ensure that the research agenda will deliver in priority areas.

Successfully incorporating these areas into the ABI will provide Australian neuroscience with a research strategy that is on par with, and complementary to, major brain initiatives being developed around the world, and that delivers major benefits to the Australian community (see Box 1).

SUPPLEMENTAL INFORMATION

Supplemental Information includes a complete author list with affiliations and can be found with this article online at http://dx.doi.org/10.1016/j.neuron.2016.10.038.

ABOUT THE AUTHORS

The Australian Brain Alliance Steering Committee, in consultation with the larger Alliance Working Group, has been responsible for developing the vision for the proposed Australian Brain Initiative. The Steering Committee consists of: Patricia T. Michie (Chair), David R. Badcock, Perry F. Bartlett, John M. Bekkers, James A. Bourne, Anne Castles, Gary F. Egan, Alex Fornito, Anthony J. Hannan, Ian B. Hickie, Jason B. Mattingley, Linda J. Richards, Peter R. Schofield, David H.K. Shum, Greg J. Stuart, James C. Vickers, and Bryce Vissel. L.J.R. drafted the manuscript. Members of the Australian Brain Alliance Steering Committee contributed to its finalization.

ACKNOWLEDGMENTS

We would like to thank all member organizations of the Australian Brain Alliance for their continued support. Members of the ABA working group have contributed to the ongoing development of the proposed Australian Brain Initiative. We are also grateful to the Australian Academy of Science (AAS) for laying the foundations for the ABA, and to Chris Hatherly, Kaori Ikeda, and Alan Woodruff at the AAS for their assistance on this project. Thanks to Jen Van Dijk at the AAS for providing Figure 1, and Nick Valmas, Queensland Brain Institute, for providing Figure 2.

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