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Bridging the Gap: establishing the necessary infrastructure and knowledge for teaching and research in neuroscience in Africa

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Abstract Advances in neuroscience research over the last few decades have increased our understanding of how individual neurons acquire their specific properties and assemble into complex circuits, and how these circuits are affected in disease. One of the important motives driving neuroscience research is the development of new scientific techniques and interdisciplinary cooperation. Compared to developed countries, many countries on the African continent are confronted with poor facilities, lack of funding or career development programs for neuroscientists, all of which deter young scientists from taking up neuroscience as a career choice. This article highlights some steps that are being taken to promote neuroscience education and research in Africa.

Keywords Neuroscience · Africa · Bridge · Funding

Introduction

Neuroscience is an important and rapidly evolving field and investment in its research and education may be an important driver of economic growth and social development (Jones 2002). This is reflected in both the amount of resources devoted to investigations of diseases of nervous system and the increasing number of major prizes being awarded for breakthroughs in the field (Clark 2013). Advances in neuroscience research and education promise to transform medicine, education, criminal justice and other fields. However, neuroscience research and related disciplines attract comparatively low interest or are shunned completely by students and researchers in many African countries, leading to an overwhelming disparity in neuroscience education between countries that are rapidly strengthening their scientific capacity and those that are lagging behind (Kennard 2000; Albornoz 2001, Alonso and Fernández-Juricic 2001; Gibbs 1995; Goldemberg 1998; Riddoch 2000).

This lack of interest results largely from the fact that many scientists in these resource limited countries are faced with challenges such as inadequate curricula to prepare students to enter neuroscience as a career choice (Juliano 2012), a pervasive lack of funding, adequate research infrastructure and career development programs, and government instability. These challenges have made it difficult for most scientists in these countries to compete with their counterparts in the developed countries for available funds or to enable established scientists or laboratories to collaborate with and support their colleagues in these resource-limited countries. As a result, most young and upcoming scientists from Africa do not take up neuroscience as a career choice, and when they do, they tend to head to developed countries, often not to return (Nature 2011).

This article discusses mechanisms and approaches that are being employed to bridge the gap in neuroscience knowledge between the developed and resource limited countries to improve research output, counteract brain drain and improve national development. The strategies considered here include the development of neuroscience programs, neuroscience research facilities and funding.

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Development of neuroscience graduate programs

Developed countries account for over 70 % of the global investment in scientific research and development (UNESCO 2010), have over 60 % of the world's researchers, and produce approximately 90 % of all scientific publications (SCI 2013). Thus, Africa's contributions to the world's research and development efforts remain very low with serious implications for scientists in African countries.

For over two decades, organizations including the International Brain Research Organization (IBRO), National Academy of Sciences (NAS), the Society for Neuroscience (SfN), the International Society for Neurochemistry (ISN), Third World Academy of Science [TWAS] and United Nations Educational, Scientific, and Cultural Organization (UNESCO), have been funding teacher training and scientific workshops to support scientists in developing countries to experience the process of designing and conducting state-of-the-art experiments. The workshops are designed to build capacity in neuroscience at African universities, advance research and improve medical care, by exposing participants drawn from different countries on the continent to lectures on basic neuroscience concepts, the latest scientific techniques and analysis of complex data. For example, since 2005, the US-Canada Regional Committee (USCRC) of IBRO has awarded many fellowships to support young scientists from developing countries to attend high-level neuroscience courses at the Marine Biological Laboratory (MBL) and at Cold Spring Harbor Laboratory (CSHL) in the USA. Indeed, the first author of this article was a beneficiary of an IBRO fellowship to attend the MBL Neural Systems and Behavior (NS&B) summer course. Awarding such fellowships to young scientists from developing countries has enabled them to be trained in cutting edge research techniques in neuroscience.

However, for these initiatives to succeed in the long term and address the prevailing need to upgrade neuroscience training in African countries, there is urgent need for a coordinated development of local, interdisciplinary graduate programs leading to the award of Master of Science (M.Sc.) and Doctor of Philosophy (Ph.D.) degrees in Neuroscience. The objectives of such graduate programs should be to educate graduate students as neuroscientists with intensive experience in at least one area of research, and to ensure that students in the program develop a broad knowledge of the field. These programs should prepare each student to make significant contributions in neuroscience and foster the development from trainee to independent research scientists and educators of future neuroscientists.

TReND (Teaching and Research in Neuroscience Development) in Africa (www.TReNDinAfrica.org), through the Institute of Biomedical Research (IBR) at Kampala International University (KIU), Uganda, is addressing this problem head-on by introducing a creative way of using cheap and readily available models to conduct cutting edge research in neuroscience, while working with the faculty at the School of Health Sciences at KIU to develop a multidisciplinary M.Sc. program in neuroscience. Because this is a new, multidisciplinary, integrated postgraduate program and the approach of introducing cheap and available models to teach neuroscience is still in its infancy, it may be some time before the success of the new curriculum and TReND in Africa programs can be fully assessed. However, early results and comments from knowledgeable individuals indicate that such initiatives can reduce the barrier in conducting neuroscience research and education in Africa and reverse the brain drain that is robbing Africa of many talented young scientists.

Neuroscience research facilities

The ability of many scientists in African universities or research groups to undertake in depth research is often hampered by a lack of modern equipment, appropriate technology and scientific literature. The cost of electrophysiology equipment can be a critical barrier to teaching neuroscience programs. Typical start up equipment used for teaching neuroscience typically costs about $3,000 and requires significant training to use and understand (Marzullo and Gage 2012). Institutions of higher learning can benefit from organizations such as TReND in Africa, Seeding Labs (http://seedinglabs.org) and Adéquation (http://adequationgermany.embl.de/). These organizations work with universities, hospitals and companies to provide second-hand laboratory and medical equipment in good condition for resource limited countries such those in Africa.

For example, an annual insect neurogenetics course organized by TReND, with support from IBRO, The Company of Biologists, AD Instruments, Cambridge University and other organizations, provides excellent foundation for those interested in pursuing research in neuroscience in African universities with the necessary tools for incorporating the fruit fly, *Drosophila melanogaster*, as a model organism for neuroscience research. The course provides equipment and expert training of junior faculty, postdocs and graduate students. At the end of the course, the equipment used in the course remains at the host institution to form the core of infrastructural support for on-site neuroscience research and education. Scientists in African universities can take advantage of this type of strategy to acquire much-needed research infrastructure and transform their institutions from mere recipients of donor funds into proactive players in their own development.

Research funding

Faced with a lack of essential services such as transport, water, power, healthcare and educational systems, or a government disinterested in investing in research, the question of how African countries can conduct cutting edge research to tackle problems related to local needs can be difficult. One solution is to form regional collaborations among scientists in these countries.

Neurex (www.neurex.org), a tri-national network of scientists, provides a good example of such regional collaboration in Europe. Neurex is composed of more than 100 specialized laboratories from three universities in the Upper Rhine region (Basel, Strasbourg and Freiburg), which involves more than 1,200 academics and researchers whose main aim is to develop scientific and industrial exchanges in the region. It is, in effect, a center of excellence that is unique in Europe. Another example is the International Institute for Neurosciences of Natal [IINN], Brazil (www.natalneuro.org.br). The Institute was established to promote implementation and growth of cutting-edge scientific research that can contribute to the educational, social, and economic development of northeastern Brazil. It has garnered praise for its socially conscious mission to foster economic development and has been cited as an example of Brazil's promising research enterprise.

The Neurex and IINN models can provide valuable examples for African countries with similar needs for neuroscience research, in retaining and attracting the brightest researchers in the field. Indeed, in the field of theoretical and applied mathematics, the African Institute for Mathematical Sciences (www.aims.ac.za) and the African Institute of Science and Technology are examples of a similarly successful endeavor on the African continent. Such structures with worldwide recognition can be developed in Africa by researchers who have established their careers in the field and have collaboration with established laboratories.

Free and open source software

The trend in the adoption and utilization of free and open-source software (FOSS) technologies for capacity building and educational applications by researchers, educators, and institutions in Africa has had dramatic impact in the development and deployment of e-learning applications in recent years (Jain 2012). However, utilization of FOSS has met with challenges due to the high cost of availability of information and communication technologies, slow or limited internet connectivity and poor telecommunication infrastructure (Giarlo 2005; Canada 2009; Dicovitsky 2010; Jain 2012).

In response to the difficulties associated with access to materials online, initiatives such as the Health InterNetwork Access to Research Initiative (www.healthinternetwork.org), Brains, Minds and Media (http://www.brains-minds-media.org), National Institute of Health Blueprint for Neuroscience Research (http://neuroscienceblueprint.nih.gov/), TReND in Africa (http://openeuroscience.wordpress.com/), the US-Canada IBRO Regional Committee (www.iacusnc.org), the MIT open courseware consortium (http://ocw.mit.edu/courses/), the Simulator for Neural Networks and Action Potentials (http://snnap.uth.tmc.edu/) and a host of others are providing free and open access to neuroscience literature (electronic journals and books), downloadable web lectures, software and interactive media, teaching resources for neuroscientists including those from countries with a low per capita Gross National Product.

To address problem of high cost of neuroscience equipment, Backyard brains [https://backyardbrains.com/] has created open source tools and low-cost set-ups called Spikerbox for recording firing neurons. Raspberry Pi foundations (http://www.raspberrypi.org/) created a credit card sized computer that can be used for many of the things that a normal PC does in areas that can't afford the power and hardware needed to run a traditional desktop PC.

Notable initiatives championed by Africans include FOSSFA (http://www.fossfa.net/) project with a mission that includes promoting the use and adoption of FOSS in Africa. The Japan Society for the Promotion of Science sponsors the project in collaboration with the United Nations University Institute of Advanced Studies (UNU-IAS) and the National Graduate Institute for Policy Studies.

African scientists or institutions can use devices such as spikerbox, raspberry Pi and a host of other FOSS to access to scientific information and promote neuroscience research and education in the continent.

Conclusion

The quest of finding low-tech, high impact ways to deliver neuroscience training to scientists in Africa should not be viewed just as knowledge transfer but as a spark that leads to new collaborations and a stronger global science community. It is hoped that the strategies discussed in this paper will help to bridge the gap in neuroscience research and education between resource-limited and developed countries. Among other advantages, these efforts will demonstrate to development partners a strong commitment to neuroscience research.

Ultimately, deliberate policies need to be enacted by African nations to sustain scientists and science development for national and regional development or else its brightest students will keep heading for distant lands and greener pasture.

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