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NeuroView

TReND in Africa: Toward a Truly Global (Neuro)science Community

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TReND is a volunteer-scientist run charity dedicated to promoting research and education on the African continent. Focusing on neuroscience, we discuss approaches to address some of the factors that currently stifle Africa's scientific development and our experience in implementing them.

The Case for a More Global Scientific Community

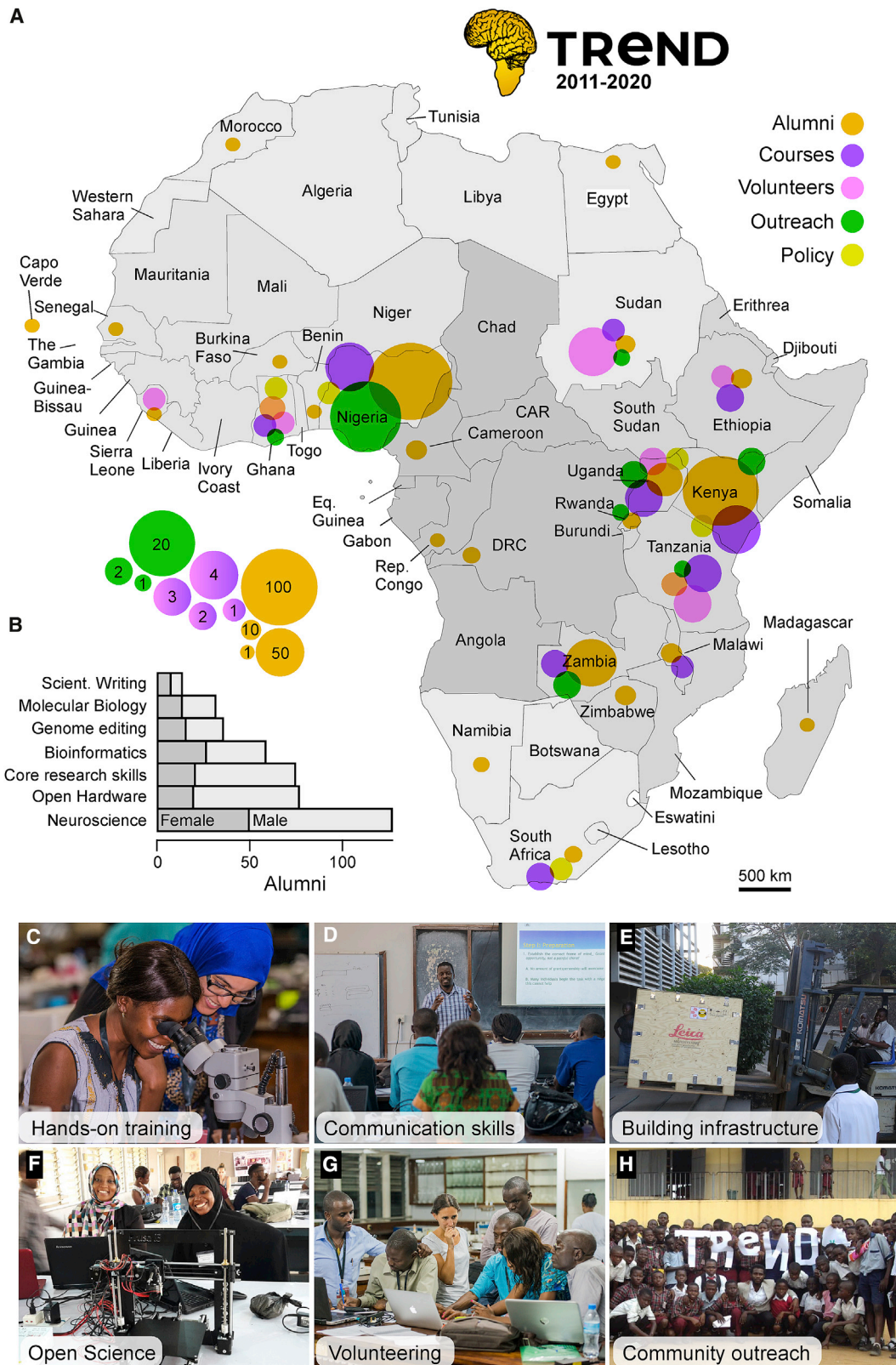
If Ebola, Zika, or the coronavirus disease 2019 (COVID-19) have taught us anything, it might be that in modern life sciences, there is no such thing as a local problem. Accordingly, now more than ever, we need to increase global research capacity and expand scientific literacy, with a focus on those parts of the world that have traditionally been left behind the most. This notably includes large stretches of the African continent, which is home to one in seven people worldwide but contributes less than 2% to the global research output (Thelwall, 2017). Here, we urgently need to reach a critical mass of well-trained and internationally connected scientists supported by scientifically literate citizens and governments, which can tackle problems before they enter the world stage.

Access to higher education and current scientific progress remains a scarce resource across large parts of the African continent. Capacity building projects have classically focused on primary and secondary education, with comparatively little attention directed toward the critical roles of the tertiary tier, although this trend has steadily changed in recent decades (Riddell and Niño-Zarazúa, 2016). Top-level science education and primary research are pivotal to the ability to innovate, move forward, and meaningfully integrate with the global society. Moreover, better positioned universities train better teachers and boost scientific literacy in the population. A flourishing research landscape also promises to increase the willingness of governments to formulate evidence-based policy.

Though small when compared to its total population, Africa boasts a substantial university and research landscape,

with countries including South Africa, Egypt, Kenya, Tanzania, Uganda, Nigeria, Ghana, or The Gambia hosting some of the world's leading research institutes in various fields (<https://research.webometrics.info/en/Africa>). Several African universities, led by the University of Cape Town in South Africa, are ranked in world university league tables. Clearly, the continent hosts an ever-growing number of scientists with potentially game-changing ideas. These factors form a solid base upon which educational and research development initiatives can operate.

The problem, however, is that examples of leading African research institutes are sparse when considering the continent as a whole. This is compounded by a series of challenges that many African-based researchers and educators endure. Beside obvious factors, such as poor funding, unreliable power grids, and



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difficulties in importing specialized equipment and reagents, one pressing issue is a disconnect from the global scientific community.

Researchers in the Global North typically learn about scientific advances long before they are formally published by attending conferences and by maintaining close personal dialogs with colleagues. In contrast, attendance at international conferences by African-based researchers is routinely obstructed by funding, visa issues, or a crushing overload in administrative duties. This hampers the development of important personal contacts with researchers abroad and thus leads to a lack of access to information about the field's current state. Journal paywalls are a further complication, although initiatives like the HINARI program (<http://www.who.int/hinari/>), the rise of open-access outlets, increased adoption of preprint servers, and the formulation of Plan-S (<https://www.coalition-s.org/>) have made progress toward addressing this problem.

These access issues compound with another prevalent problem at many African universities: the dramatic shortage of teaching personnel. Besides administration, senior academics usually face a crushing teaching overload, often having to run multiple repeats of crowded seminars for hundreds of students at a time in sometimes woefully inadequate teaching spaces (Marais, 2016). To fill this teaching gap, universities routinely employ junior academics (often at the MSc level) to teach. This practice has led to a vicious cycle of low teaching quality where even theoretical aspects of many topics are only superficially covered. This is finally worsened by a near complete absence of practical training in modern research approaches in university science curricula (Ozor et al., 2016).

Neuroscience Research Capacity in Africa

Per one million inhabitants, most African countries have fewer than 100 re-

searchers—compared to a global average of currently 1,080 researchers and more than 4,000 researchers in scientific powerhouses like the UK, USA, or Japan (<http://chartsbin.com/view/1124>). Similarly, on average, 3 neurologists serve 10 million people in Africa, compared to nearly 500 neurologists in Europe (Mateen et al., 2016). These numbers contrast with forecasts that by 2050, 71% of people living with dementia or related neurological conditions will be from low-to-middle income countries, which currently includes most African countries (Prince et al., 2013). Ultimately, long-term solutions to problems such as these must come from within Africa, with concerted actions from governments and African-based philanthropists supporting a thriving African research sector. However, in parallel, it will be critical to better integrate African neuroscientists into the global scientific community.

In 2011, to catalyze these efforts and to contribute to the development of a truly global scientific community, with an initial focus on neuroscience, we founded the non-profit organization TReND in Africa (<https://www.TReNDinAfrica.org>). Here, we summarize our actions (Figure 1) in the context of other programs with closely aligned goals, focusing on (1) (neuro)science capacity building, (2) promoting scientific exchange, and (3) public outreach and policy engagement.

(Neuro)science Capacity Building

A plethora of advanced, hands-on neuroscience courses are offered across the Global North, including those by Woods Hole Marine laboratories, Cold Spring Harbor, the Federation of European Neuroscience Societies (FENS), or the CAJAL program. Many of today's most influential neuroscientists were once students at courses such as these, and for some, they remain instrumental to their careers even years later. Yet, despite the international nature of these courses, few participants come from Africa. Instead, African-based students are rarely selected in view of their often comparatively limited research experience, an

absence of glowing recommendation letters from well-known scientists, and/or the applications' formatting to different cultural expectations. Even when selected, a student's ability to attend a course is routinely hampered by lack of funding, even when partial scholarships are provided, or by visa requirements. Finally, if all these hurdles are overcome, attendees often realize that much of the training received might be difficult to apply when faced with the realities of the research infrastructure back at home. This can have a counterproductive effect, with some applicants leaving these courses more discouraged to pursue research than when they first applied.

Realizing these limitations, international organizations, such as the International Brain Research Organization (IBRO) and the International Society for Neurochemistry (ISN), have invested into funding neuroscience training courses in Africa. Building on these efforts and with help from a wide range of additional funders (see Acknowledgments), TReND organizes top-level and hands-on training courses in collaboration with African universities and research institutions (Figures 1A–1D). To date, we have trained ~500 African young scientists through more than twenty intensive and multi-week research schools. We cover diverse disciplines, including neurogenetics, neurophysiology, molecular biology, genome editing, bioinformatics, open hardware, general lab and research skills, and scientific writing (Figures 1A and 1B). To ensure equal opportunity, all courses are free of charge and usually cover travel costs and board. Ensuring gender balance as much as possible (Figure 1B), typically 15–20 participants per course from late undergraduate to faculty level are selected among candidates applying from all over Africa, with an acceptance rate of usually <10%. TReND courses are delivered by worldwide leading researchers and have a strong emphasis on hands-on training, with at least half of the course spent in lab-based practicals.

Figure 1. TReND in Africa Activities 2011–2020

(A) Impact map, summarizing course alumni (brown), courses (purple), volunteer visits (pink), outreach activities (green), and policy actions (yellow).

(B) Alumni and gender ratio by course types.

(C–H) Impressions from TReND activities, including courses (C and D), equipment donations (E), building one's own lab equipment (F), volunteering program (G), and outreach (H).

All TReND courses take place in Africa, and we complement existing resources with donated scientific hardware and reagents to ensure that the taught state-of-the-art techniques can be replicated in a typical African university setting. We therefore combine our courses with an equipment donation program (Figure 1E), available to our alumni and partner universities. The need for research-grade equipment in emerging economies has long been recognized, for example, by the WHO equipment funding programs and non-profit organizations, such as Seeding Labs (<https://seedinglabs.org>). Industry and well-funded laboratories often discard or store fully functioning equipment and reagents that have become superfluous to current requirements, yet they present a vast resource for underfunded labs around the world. Our equipment donation program aims to activate these resources for African universities. Importantly, African countries should not be the end point of e-waste, nor should shipped equipment end up unused. For this reason, we thoroughly test all donated equipment prior to shipping and link donations with courses or volunteer visits (see below) to make sure that there is expertise on site to efficiently make use of the donated equipment.

Another defining feature of our courses is a strong focus on open science, including the promotion of free and open-source software and do-it-yourself (DIY) equipment based on open-source hardware designs (Baden et al., 2015; Tsanni, 2020) (Figure 1F). We also teach how to build or repair equipment based on off-the-shelf electronics and 3D printed parts—either as part of an introductory week or as dedicated courses in their own right. These activities reinforce a mentality of innovation and frugality and dispel the commonly held misconception that state-of-the-art research categorically requires expensive equipment.

In general, we adapt all aspects of taught materials to local realities, including local budget constraints. This includes discussions on the most appropriate model organism to each research question. Therefore, many courses focus on the use of genetically accessible invertebrate model systems, such as fruit flies

or nematodes, as these are not only powerful but also affordable and easy to maintain. For the same reasons, where vertebrates are used, we aim to promote the use of small and comparatively cost-effective models (e.g., zebrafish or medaka). We also encourage the use of local resources, such as investigations on local animal and plant species. Altogether, these measures increase the chances that students can meaningfully implement what they have learned once they return to their home institutions.

Promoting Scientific Exchange

Global exchange of information is key to scientific progress, but interactions between African researchers remain sparse, both within Africa and beyond (Maina et al., 2020). Several initiatives are aimed at reducing this gap.

Although targeted courses like those mentioned above can go a long way in fostering important international links, they can be expensive and difficult to scale to the required levels. Therefore, we complement our courses with a volunteering program (Figure 1G). Scientist-volunteers from around the world register interest to organize on-site training or provide focused advice in their specific area of expertise. From here, our African partners periodically receive a curated list of available volunteers and can submit specific requests based on their local needs. Once mutual interest is established, details for the visit are discussed directly between the volunteer and the hosting institution, with guidance from TReND members as required. In some cases, limited funding might be available, for example, when volunteers are based at institutions that offer scholarships toward this program (e.g., the Francis Crick Institute or the Max Planck Society). In other cases, costs can be flexibly shared between the volunteer and the host institution. This program enables personal international collaborations to form and is both nimbler and more scalable than the abovementioned research courses.

Another model taken by many organizations is to provide fellowships for African scientists to spend time at western institutions, such as the Crick Africa Network, the Graduate Programme for Science and Development (PGCD) of the Gulbenkian Institute in Portugal, or the Spanish Women for Africa Foundation.

Like our volunteering program, these initiatives can go a long way in developing personal links among researchers worldwide.

Although the most popular approach to scientific exchange might be through conferences, these have largely remained geographically segregated. For example, the meetings of the Society for Neuroscience (SfN) in the USA or of the FENS both attract impressive international crowds, but typically few participants are African-based. In contrast, the meeting of the Society of African Neuroscientists (SONA) concentrates an impressive line-up of African labs but attracts comparatively few non-African scientists. TReND aims to link societies such as SONA and FENS to increase international representation at these meetings, for instance through travel-fellowships. Eventually, transforming neuroscience conferences into a mix of in-person and online forums promises to go a long way in making these events more globally accessible. The current situation generated by COVID-19 has shown us that online meetings are not only possible but also effective. In response, the FENS 2020 conference has gone online, and worldwide participation will be facilitated through the provision of large numbers of fee-waiver scholarships. Other conferences, such as the Genetics Society of America (GSA) 2020, have waived fees altogether. In parallel, many online seminar series are springing out of the ground. Community-generated online conferences like <https://neuromatch.io> or seminar platforms like <https://www.worldwideneuro.com> (WWN) (Bozelos and Vogels, 2020) rapidly emerged, routinely attracting thousands of hits worldwide, including a growing African participation. In fact, SONA joined WWN early on, hosting both African and non-African speakers. Indeed, some African scientists have been hosting online talks long before COVID-19 hit the world stage. To facilitate these efforts, TReND has worked with the Sudanese Researchers Foundation (SRF) since 2016 and with SONA since 2019.

Going forward, it will be important to continue providing broad online access to conference talks in the future. It might be as simple as online streaming departmental seminars or international

conferences, with one person on-site curating questions and comments for the speaker.

Public Outreach and African Science Policy

Ultimately, a strong African research sector can only emerge from within, supported by scientifically engaged governments and a general public that supports research and development (R&D) spending. Accordingly, promoting scientific literacy and evidence-based thinking is pivotal. To this end, TReND runs a sizable outreach and policy engagement program broadly focused on school children and the general public, including decision makers. This branch of TReND is African led and to a large extent comprised of our course alumni (Figure 1H). These African-based TReND members form a tight, pan-African community of scientists that continue to engage with each other long after courses are finished. Importantly, while engaging in outreach activities, they can serve as believable role models and can communicate in local languages if needed. To date, TReND has run several dozens of targeted outreach activities (Figure 1A), engaging with schools, universities, and the general public through a variety of formats. Activities can range from school visits for an afternoon via organized hands-on experiments for children to multi-day science festivals that involve schools, parents, teachers, and local government representatives. Many outreach events are coordinated with equipment and reagent donations, for example, by providing light-microscopes to primary schools where outreach activities are held. These activities are supported by a wide range of funders (see Acknowledgments). Moreover, since they are always organized by researchers who understand the local realities of their community, including local prices, they can achieve great impact with minimal funding.

Conclusion

Africa's scientific landscape is extremely heterogeneous, including both world-leading research centers and institutes of higher education where local circumstances make research all but impossible. Accordingly, the promotion of science education and research requires strategies that are adapted to local realities: a "think globally, act locally" approach. The Sustainable Development Goals 4 (SDG4) of the 2030 agenda focuses on high quality education and has two central pillars, which focus on improving learning outcomes and including those who are excluded. Across the continent, there are many organizations engaged in the promotion of research, science education, and policy (e.g., https://en.wikipedia.org/wiki/List_of_organizations_engaged_in_STEM_education_across_Africa). Many organizations focus on specific geographical regions, fields of science, or types of support. Jointly, these grassroots organizations are key players in making inroads in the long run. They tend to be cost effective and highly sensitive to local realities, which are difficult to accurately judge for major funders. Accordingly, the most impactful initiatives are likely to be those that intimately involve African-based researchers. As part of this, it will be critical to support them to facilitate engagement with the global scientific community. Only in this way can they gain the visibility and support for leading the way in Africa's scientific future.

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