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Commentary

Why South Africa needs cognitive neuroscientists

Kate Cockcroft

Abstract

Despite a long-standing and growing popularity in the minority world (wealthier regions that represent a small percentage of the world population), cognitive neuroscience has been slow to attract South African researchers and practitioners. This brief commentary reflects on why South Africa needs its own cognitive neuroscientists. Prevailing theories and constructs in the field are developed from minority world populations and are taken unquestioningly to reflect the neurocognition of all humanity. A significant potential contribution by local cognitive neuroscientists would be to challenge and critique these theories and constructs underlying neurocognition. Without representation from majority world contexts (developing nations whose populations form a significant demographic majority in the world), like South Africa, cognitive neuroscience will continue to be biased and its findings ungeneralizable. In addition, the contribution of South African cognitive neuroscientists extends beyond the conceptual. Currently, those working in the field have made some noteworthy contributions that have made a material difference in the lives of South Africans. Selected examples of these are provided. The future research agenda for the field promises increased integration of contributions from artificial intelligence (AI), psychometrics, bioinformatics, and genetics, as well as collaborative and open sharing of data. It is vital that South African cognitive neuroscientists keep pace with these developments.

Keywords

Cognitive neuroscience, South Africa

Cognitive neuroscience is a relatively new field that spans multiple disciplines, connecting cognitive science, neuropsychology, and cognitive psychology to biology and neuroscience. Its distinct identity was driven by methodological advances that enabled non-invasive study of the brain,

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mind, and cognition in the 1970s and 1980s. Prior to this, neuropsychologists studied patients with brain lesions to inform theories of typical cognition, and cognitive psychologists used experimental methods to understand how humans process information. These approaches produced some fundamental, and often unexpected, insights about cognition. However, lesion studies and cognitive experimentation in isolation had inherent limitations, and historical schisms kept cognitive and biological approaches to studying the brain and cognition separate. The advent of structural and functional neuroimaging technologies enhanced the ability to examine the neural correlates of cognition, and the field of cognitive neuroscience rapidly emerged. Today, cognitive neuroscience draws on methods from m(any) disciplines (e.g., anatomy, bioinformatics, computer science, linguistics, philosophy, and physiology) in its attempt to understand the mechanisms that subserve cognition at different points in the life cycle (Ward, 2020). So, the field of cognitive neuroscience includes everyone working collaboratively across traditional disciplinary boundaries to understand how the physical operations of the brain give rise to cognitions and behaviours. The aim of this commentary is to argue for how South Africa can benefit from work in this field by calling attention to some of the issues that could be addressed. This argument is strengthened by highlighting a few examples that illustrate the work of local cognitive neuroscientists.

Cognitive neuroscience in Africa and South Africa

Despite its popularity in the minority world, cognitive neuroscience research in Africa and South Africa is sparse. Barriers that limit neuroscience research from Africa are detailed by Besharati and Akinyemi (2023) and include few active scientists, with high administrative and teaching loads, limited funding, and inadequate research infrastructure. Of the restricted number of African neuroscience publications, nearly 70% have co-authors based outside Africa, and there are fewer inter-African collaborations than there are collaborations beyond Africa (Maina et al., 2021). This may reflect funding models that require such partnerships and/or illustrate beneficial co-operation across continents, but it is unclear which studies were African-led and which were extractive science[1] (Maina et al., 2021). Naturally, South Africa (and Africa) can profit from such mutually beneficial collaborations by developing expertise to challenge existing theories and constructs of brain–behaviour relationships, which have thus far been largely developed and refined on select participants who do not represent all of us (Arnett, 2008). One reason for this lack of representativity is that some neuroscience technologies have systemic biases related to the geographic areas in which they were developed and are primarily used. For example, electroencephalography (EEG) electrodes are designed to function optimally on certain hair types and styles that exclude participants with African hair and hairstyles unless ‘special’ (and costly) electrodes are purchased. Consequently, African participants are extremely under-represented in EEG research (Choy et al., 2022; Zondo et al., 2024).

Opportunities for South African cognitive neuroscientists

As all brain–behaviour relationships are embedded in cultural context, South Africa’s rich cultural diversity provides an interesting context that may shed light on different culture–brain–cognition relationships to those traditionally represented in the research. For example, traditional neurocognitive assessment that provides the tools for both diagnosis and research is based on skills that are considered important within the minority world, but which may not be valued or relevant within African culture. South African cognitive neuroscientists are consequently confronted with several difficulties. First, most standardization data[2] for these tests derive from similar advantaged contexts, with limited validity for non-English speaking, technologically less advantaged, and socioeconomically and educationally disadvantaged populations. Second, most theoretical conceptualizations of cognitive constructs on which neurocognitive tests are based originate from English-speaking, Western, technologically, and educationally advanced contexts (Shuttleworth-Edwards & Truter, 2023). Local neuropsychologists and researchers have addressed the first challenge by collecting demographically detailed subgroup norms that closely approximate the subgroup to which a respondent belongs in terms of relevant demographic sociocultural variables, such as socioeconomic status and quality of education, to tease out the differential effects of these variables. Demographically focused norms, even with small samples, are more diagnostically informative than large samples without stratification for critical variables that influence cognition, such as level and quality of education (Ferreira-Correia & Cockcroft, 2023; Shuttleworth-Edwards & Truter, 2023). In addition, challenges related to representative data sets extend to neuroimaging, where the 'average' brain is still largely based on White, heterosexual, right-handed men with no history of physical/mental illness, despite attempts to diversify such data sets (Beaulieu, 2001; Bethlehem et al., 2022). This is a critical issue, as the trend in neurocognitive assessment is towards the incorporation of imaging data together with psychometrics (Bilder, 2011).

Second, representative norms do not address the lack of cultural equivalence or construct validity in neurocognitive measures, as culturally salient abilities are not extensively assessed (Manly, 2005). Despite calls to study cognition in cultural context, there is still a tendency to generalize from studies in minority contexts to the rest of the world, and efforts to address this issue are significantly less extensive than those aimed at addressing normative concerns (Arnett, 2008; Cockcroft, 2022; Stein et al., 2016). Nicknamed the 'Rainbow Nation' because of its multiculturality (Rainbow nation, n.d.), South Africa is able to contribute more diverse samples of brain–behaviour relationships to enable a more accurate picture of these relationships and to explore whether prevailing constructs and models of cognition are suitable for South Africans.

Contributions made by South African cognitive neuroscientists

Notwithstanding the above difficulties, South African cognitive neuroscience has provided practical solutions to the numerous challenges facing our people. Pragmatic and innovative solutions can contribute globally as there are low-resource settings in most countries. For example, South Africa has high rates of disease and disability related to HIV infection, with the highest estimated infection rate globally (Statistics South Africa, 2021). HIV causes neurocognitive impairment (Benki-Nugent & Boivin, 2019), yet no screening for such impairment typically occurs in South African clinics because of limited funds and expertise. The medical and functional consequences associated with mild neurocognitive impairment are considerable (e.g., increased risk of mortality, greater likelihood of more severe impairment, disruptions to daily activities, such as antiretroviral therapy [ART] adherence, and decreased quality of life), placing sufferers at risk for worse health outcomes (Robbins et al., 2014). It follows that a simple process, such as early screening for such impairments, can assist with comprehensive care and treatment strategies and prevent a cascade of later difficulties. Restricted access to state-of-the-art technologies has compelled South African cognitive neuroscientists to draw on the omnipresent smartphone. Their low cost, easy-to-use touchscreens, network connectivity, portability, and powerful processing capabilities make smartphones a valuable resource, offering greater efficiency, accessibility, accuracy, and interactivity to neurocognitive testing. Consequently, smartphones may be one way of addressing the unequal access to technology and differing levels of digital competence in the country, as most adults appear to possess one (Mogoba et al., 2018). Accordingly, Robbins et al. (2014) modified a smartphone application (app; NeuroScreen) for successful use in South Africa to detect HIV-related cognitive impairment. Similarly, smartphone applications (apps) have been used for cognitive interventions, such as the Curb Your Addiction (CY-A) app to train the neural processes underlying working memory in methamphetamine addicts, with cognitive gains evident 2 years later (Brooks et al., 2020).

In addition to apps, screening tools have been adapted for use with children living with HIV (Knox et al., 2018), whereas others have explored those cognitive functions impacted in children living with HIV (Cockcroft & Milligan, 2019; Milligan & Cockcroft, 2017), as well as whether cognitive interventions could assist children and adolescents who are HIV-positive to improve (and maintain) their working memory capacities (Fraser & Cockcroft, 2020). This is important, given that working memory enables us to manage progressively more complex information and is critical for effective functioning in the world, being involved in (among others) learning, decision-making, problem-solving, interpersonal skill, self-regulation, and resilience (Bemath et al., 2020; Cockcroft, 2015). Similar interventions have improved attention skills in children from low socioeconomic settings (Schrieff-Elson et al., 2017) and with traumatic brain injuries (TBIs; Lanesman & Schrieff, 2021). This is an important venture as South Africa has one of the highest rates of TBI globally and it is among the leading causes of disability in South Africa (Gxolo, 2021). These examples show that essential early neurocognitive screening and interventions are possible (with a measure of resourcefulness) in circumstances of financial and expertise constraints.

Another area to which South African cognitive neuroscientists contribute is a better understanding of neurodisabilities. For example, we have the highest incidence of Huntington's Disease-like 2 (HDL2) sufferers, resulting from a rare genetic mutation linked predominantly to African ancestry (Ferreira-Correia et al., 2020). South African research into HDL2 has contributed to improved diagnostic techniques and treatment methods for sufferers of the disease (Ferreira-Correia & Cockcroft, 2023; Krause et al., 2024).

Conclusion and future directions

Future work should continue the focus on critical questions and practical solutions to our many health, education, development, social, and economic challenges. Understanding the neurocognitive mechanisms underlying social-affective behaviours and executive functioning (such as decision-making, planning, prioritizing, and problem-solving) can contribute to interventions and policies aimed at promoting social cohesion and well-being and at addressing inequality and poverty. Globally, the research agenda for the field is towards greater integration of contributions from genetics, neuroimaging (e.g., the National Institute of Mental Health Connectome project), and artificial intelligence (AI), so that the thinking about brain–behaviour relationships, and how they are assessed, is constantly being updated (Bilder, 2011). Simultaneously, the ubiquitousness of the internet and information technology has changed how knowledge is represented and accessed, providing convenient opportunities for online assessment, data collection, and open data sharing. This enables rapid aggregation of information regarding previously understudied populations, to which South Africa has much to contribute (especially given that African populations have the world's highest genetic and phenotypic diversity; Gomez et al., 2014). It follows that open access to data requires a reconsideration of ethical approaches to research, particularly within the legal parameters of the South African Protection of Personal Information (POPI) Act of 2013.

Although we have technological, resource, infrastructure, and expertise limitations, which often result in slower science, we can still be resourceful in our approach to the field, particularly as South Africa offers many understudied and interesting topics (Besharati & Akinyemi, 2023). For example, South Africa's linguistically diverse population offers excellent opportunities for investigating psycholinguistic topics, such as how multiple language proficiency is related to cognition (Cockcroft, 2024; Cockcroft et al., 2019). Importantly, South African cognitive neuroscientists can add a critical assessment of who is being studied in human neurocognition, thereby challenging and changing prejudiced paradigms by expanding the participant base, by offering integrated methods and theoretical approaches across traditionally separate fields (e.g., neuropsychoanalysis; Solms & Turnbull, 2011), and by openly sharing data, resources, and expertise. Concerted efforts should be made to change negative perceptions of work under the cognition banner (some of which was previously funded by the apartheid government to produce unethical, irresponsible, and biased research to support a racist agenda; Laher & Cockcroft, 2017). Finally, expertise can be grown through the development of new and accessible qualifications, and increased collaboration and funding both within and beyond the African continent.

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Notes

1. Where researchers (usually from highly resourced countries) conduct research on populations in low-resource settings/countries, without acknowledging the importance of the local infrastructure and expertise, and fail to establish long-term, equitable collaborations with local partners (Odeny & Bosurgi, 2022).
2. Used to determine 'normative' and 'non-normative' performance.

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