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Critical neuroscience as an interdisciplinary tool for the investigation of neuro-matters

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Due to the revolution in the neurosciences and the growth in neuroscientific research, there has been a steady increase of attention on neuro-matters in science, society and culture. The brain and neuroscientific research remain at the centre of public and academic attention worldwide. Critical Neuroscience is an interdisciplinary (or better, post-disciplinary) space for the systematic exploration of neuroscientific research and neuro-matters. It is argued that Critical Neuroscience, as a recent addition to neuroscientific research, has the potential to develop as a genuine human science for the investigation of the role and influence of the brain on human phenomena. Together with the growing interest worldwide in neuroscientific research, engagement with neuro-matters in general asks for a critical engagement with one of the fastest growing areas of scientific research.

Neuroscientists take it for granted that the way we behave and experience the world is determined by the way our brains work (see Frith 2004: 239) In fact, one of the fundamental principles of neuroscience "is that all experiences are the result of brain activity" (Comings 2007: 279). Thus, a working assumption in neuroscientific research is that the human neurobiology shapes human actions and sets the conditions for the lives of human beings in societies (Rose & Abi-Rached 2013: 226). Therefore, the dramatic increase of knowledge about the structure and working of the brain and central nervous

system in the past few decades, known as "the revolution in the neurosciences", has placed the brain at the centre of one of the most interesting and fastest growing scientific fields, with implications covering a wide range of areas (Ramachandran 2004: 2).

While the 1990s was declared the "decade of the brain", the twenty-first century is being heralded as the "century of the brain" (Vidal 2009: 7). Therefore, it is not surprising that two of the most ambitious scientific projects to date are mapping the human brain. On 2 April 2013, US President Barack Obama announced financial support of millions of dollars for the Brain Activity Map project (BAM) whose aim it is

> to create and apply a new generation of tools to enable the functional mapping and control of neural activity in brains with cellular and millisecond resolution [...] the Brain Activity Map (BAM), could put neuroscientists in a position to understand how the brain produces perception, action, memories, thoughts, and consciousness and be a major step toward a complete understanding of brain function and dysfunction (Alivisatos et al. 2012: 1284).

More than eighty institutions in Europe are collaborating on the European Union's The Human Brain Project with a view to understanding the human brain. Their vision states:

> Understanding the human brain is one of the greatest challenges facing 21st century science. If we can rise to the challenge, we can gain profound insights into what makes us human, develop new treatments for brain diseases and build revolutionary new computing technologies (Human Brain Project 2013).[1]

It is no exaggeration to say that neuro-matters occupy one of the central key positions in the contemporary scientific landscape.

A cursory overview of the research topics, as presented on the web page of the Southern African Neuroscience Society, shows that they are almost exclusively limited to clinical and basic neurophysiological research.[2] Although South Africa has a limited capacity to participate in experimental and clinical neuroscientific research, the country may nevertheless benefit from the revolution in the neurosciences. This article argues that Critical Neuroscience, as an interdisciplinary development, offers a framework and theoretical tools to pursue neuroscientific research in addition to the above-mentioned neurophysiological

1 Human Brain Project, 2013. <http://www.humanbrainproject.eu/vision.html>

2 Southern African Neuroscience Society <http://www.sans.org.za/>

projects. The brain as well as matters of the brain are important, and for that reason, interdisciplinary neuroscientific research can be conducted beyond the confines of the excellent research done mostly at medical schools and focusing on brain disorders. In order to advance this argument, it is necessary to first examine the terrain of neuro-matters.

1. On neuro-matters

Generally speaking, neuroscience focuses on an understanding of the human brain and the nervous system as well as the growing body of knowledge about the working of the brain. The increase in our understanding of the brain highlights the fact that the brain matters in ways unknown or expected in previous times. However, with the increase and sophistication in the understanding of the brain comes the impact of neuroresearch on the understanding of human life and humanity in general. In this article, the term 'neuro-matters' refers to both these aspects: the brain matters and matters of the brain.

1.1 The brain matters

As an organ, the brain is like a hub coordinating bodily, social and cultural life. It is a key organ in the organisation of experienced life and central to the constitution of what it is to be a self, to be conscious and to have consciousness. Academic disciplines as well as social and cultural life have been affected by the revolution in the neurosciences. This revolution brought about remarkable results in terms of a spectrum of areas: "Neuroimaging advances, psychopharmaceuticals with enormous potential for clinical use, neural-technological interfaces, brain stimulation technologies, and organic implants such as fetal cell therapy are transforming our ability to understand and intervene in the brain" (Wolpe 2002: 8). In fact, some astonishing results have been produced: "Neuroimaging and psychopharmaceuticals are only the tip of the neuroscience iceberg. Implantable computer 'brain chips' are allowing the blind to see, the deaf to hear, and monkeys to control cursors on computer screens entirely with their minds" (Wolpe 2002: 8, see Swaab 2014).

Increased knowledge about brain structures and mechanisms as well as the revolution in the neurosciences provide analytical tools for understanding a variety of human phenomena, from mental illness through cultural and religious beliefs and practices and the human self, differently. For example, the neurophilosopher Thomas Metzinger (2009: 213) predicts that the consciousness revolution, which is driven by brain research, "will affect our image of ourselves much more dramatically than any scientific revolution in the past", while

others are more cautious in admitting only that "our conceptions of human personhood [...] are undoubtedly being reshaped" by neuroscientific research (Rose & Abi-Rached 2013: 233). In general, the neuroscientist Antonio Damasio (2010: 30) suggests that knowing how the brain works matters a great deal for how we live our lives, because understanding ourselves better impacts on the way we live.

Amidst great advances, it is also often admitted that, in fact, very little is known about the brain, and the working of one of the most complex systems in the natural world remains a mystery. The majority of neuroscientists, realising that they are merely scratching the surface of understanding the brain, are quick to acknowledge that current knowledge of the brain's structure, function and mechanisms is in its infancy – as Ramachandran (2011: 5713) explains with an analogy from chemistry: neuroscience is now where chemistry was in the nineteenth century in discovering basic elements and placing them into categories for studying their interactions. Or, in the words of Trimble (2007: 2631), "[w]e simply do not understand how the brain works, and to kid ourselves otherwise is only an example of our brains kidding ourselves". Furthermore, neuroscientists disagree on the most fundamental assumptions about the way in which to investigate the brain's workings, because they disagree about what the brain is. Despite these obvious reservations and admitting the remarkable achievements already made, few will disagree that understanding how the brain works remains "arguably one of the greatest scientific challenges of our time" (Alivisatos et al. 2012: 970). Next to the question "How did the universe come into being?", Dick Swaab (2014: xix) considers this one of the greatest scientific questions of this century. There is no end in sight to this revolution.

There is less agreement as to how precisely neuroscientific research should continue. It is, however, obvious that brain research is no longer confined to the causes of brain disorders, but seeks to find ourselves; it is a quest "to establish why we are as we are" (Swaab 2014: 3). By definition, this is a concern of the human sciences. A great deal of current neuroscientific research is focused on the working of the healthy brain and, even without access to modern brain-scanning facilities, it is possible, based on the revolution in neuroscience, to participate in this quest for understanding ourselves better.

1.2 Matters of the brain matter

The term 'neuroscience' goes back just over fifty years to the establishment of the Neuroscience Research Program (NRP) in the US at the Massachusetts Institute of Technology (MIT) which aimed to do for the brain what others were doing for the genome. At the time, the term combined the 'neuro-' disciplines (neurophysiology,

neuro-anatomy, neurochemistry and neurology) as well as the 'psy' disciplines (psychology and psychiatry) (Rose & Abi-Rached 2013: 25-6). At present, it also covers the numerous burgeoning neuro-prefixed disciplines such as neuro-economics, neuromarketing, neurolaw, neurotheology, neuro-education, neurophilosophy, neuro-ethics, and so on (Vidal & Ortega 2012: 10069, Trimble 2007: 69) as well as subdisciplines such as neuropsychology, social neuroscience, cultural neuroscience, cognitive neuroscience and neuro-anthropology. Neuroscientific research obviously goes back far beyond this use of the term, but should currently be viewed as an alliance of many disciplines (Rose 2012). The interdisciplinary term 'neurosciences' implies that the brain matters, but also includes the 'matters of the brain', which refer to everything that is covered by the interdisciplinary research programme.

Neuroscience is not a unified field of research and certainly no single discipline, but an interconnected network of research areas, problems and fields that are in different ways associated with research on the human (mammalian?) brain. Few other scientific fields are as prominent in academic and public life and are currently making as much progress as the neurosciences. On the one hand, there is an unprecedented opportunity for comprehensive collaborative and interdisciplinary research in the unifying interests in things 'neuro-'. Never before has any prefix captured the imagination of scholars from so many disciplines or provided a site for a comprehensive investigation of a single aspect of the natural world. On the other hand, the hype gives reason for caution. One of the hallmarks of these neuro-prefixed disciplines is the search for neural correlates by means of neuro-imaging studies (Vidal & Ortega 2012), for example, in adolescent risk-taking, sex differences, mental illnesses, or uncovering the brain mechanisms underlying cognition, emotion, decision-making, spirituality, and so on (Slaby & Choudhury 2012). Such neuroscientific explanations of behaviour fit well with the "cultural focus on the individual and interiority" (Choudhury et al. 2009: 62). Therefore, there is a concern that the authority of the scientific enterprise and, in particular, the neuroscientific enterprise, which is supported by the rhetoric of high-tech imaging techniques and the influence of big pharmaceutical companies, could have negative consequences for individuals and society.

> The avalanche of neuroscientific research and its popular presentations are generating a growing belief, among policymakers and in public culture, that human neurobiology sets the conditions for the lives of humans in societies and shapes human actions in all manner of ways not amenable to consciousness (Rose & Abi-Rached 2013: 225).

For these reasons, neuroscientific research cannot be restricted to clinical and experimental neuroscience, but should involve scholars from a wide range of disciplines, especially from the human sciences.

In summary, the 'brain matters', because it is the central organ organising human life, because of the revolution in the neurosciences, and because of the impact of neuroscientific research on academic, social and cultural life. The brain and brain (neuroscientific) research matter because they have become a focal point in numerous scientific and cultural practices. On the international scene, the neurosciences already represent a plethora of approaches and methods that are interested in neuro-matters. Therefore, the suggestion is that Critical Neuroscience is a necessary and essential contribution to the neurosciences, and its concern with neuro-matters provides an unique space for interdisciplinary engagement.

2. On Critical Neuroscience as a post- and interdisciplinary site

Critical Neuroscience is a very recent addition to the domain of the neurosciences. According to Choudhury & Slaby (2012: 443), it arose "in response to the tremendous pace of developments in neuroscience during the last two decades, in particular the increasing emphasis of its findings in the social and cultural life of human beings". The influence and relationship between experimental and Critical Neuroscience are multi-directional. Various reciprocal interactions are implicated between clinical and experimental neuroscience and its impact on society, culture and academia, in general, as well as within various neuroscientific practices, in particular. At the core of Critical Neuroscience is the goal to examine these "reciprocal interactions between neuroscience and social life" (Choudhury & Slaby 2012). Broadly speaking, Critical Neuroscience, therefore, works in two directions: one is that of experimental and clinical neuroscience and the other is the application and utilisation of neuro-knowledge in society, academia and culture as such. Choudhury & Slaby (2012: 474) explain this as follows:

> Our claim is that a sustained engagement with neuroscience is necessary to provide a more accurately informed picture of what is actually happening in and around the neurosciences. It is this kind of engagement we want to cultivate: on the one hand tracing the journeys of 'brain facts' between neuroscience laboratories and their various sites of appropriation and application in the institutions, discourses, and practices that constitute our human lifeworld; and on the other hand probing whether contextual knowledge gained in this way can be reflexively

> applied to the practice of neuroscience to complement existing approaches, by inspiring enriched paradigms and broadening interpretive possibilities.

Three features of this emerging and developing trend in the neurosciences can be used to describe Critical Neuroscience as a post- and interdisciplinary site.

2.1 Critical Neuroscience is not a neuro-discipline

Critical Neuroscience is not a new neuro-discipline, but in the words of Choudhury and Slaby (2012: 1315) "undisciplined" — it is an interdisciplinary, or better, post-disciplinary site and activity analysing the totality of neuroscience and its influence on society. Its aim is not to develop a new discipline, but to add a critical edge to existing neuro-disciplines. In the words of those who initiated Critical Neuroscience in 2008 as an interdisciplinary project: "We envision Critical Neuroscience to be a collaborative activity by those working within the neurosciences, and those who study the field or work with its findings" (Choudhury et al. 2009: 69). In his summary of what Critical Neuroscience should do, Rose (2012) lists six features. His final feature is that

> it needs to do all these [see further below] without simply becoming professionalized into a new academic discipline, speaking only to itself without engaging either working neuroscientists, or, more importantly, the wider civil society. If it can achieve these goals, it will truly justify its self-designation as 'critical'.

Therefore, Critical Neuroscience is not a discipline, but an interdisciplinary space, gaze and set of activities. This is apparent from Kirmayer's suggestion that it borrows from the critical philosophical tradition as well as from various social science traditions in order to interrogate the practice of neuroscience and to understand how 'facts' about the brain have come to be so salient in clinical, educational, and commercial settings and in the popular imagination. In his words: "Critical neuroscience depends on establishing a position outside the activity of neuroscience itself, from which one can question and critique the models, assumptions, and accounts of biology and experience that constitute neuroscience and its public image" (Kirmayer 2012: 369). In other words, it is a critical, reflexive and interdisciplinary way of academic involvement in neuro-matters, while sharing with experimental neuroscience the notion of the relevance (but not the primacy) of the brain in understanding human phenomena.

In view of this, it is not necessary to establish new academic disciplines in order to participate in the neuroscientific revolution. South African scholars, even without access to facilities for brain imaging and experimental neuroscientific

research, can contribute to this revolution. It will require innovative thinking about the impact of the results of neuroscientific research on aspects of human nature and what it means to be human as well as the forging of interdisciplinary discussions and research teams that can rethink human matters in the light of neuro-matters.

2.2 Neuroscience beyond neuroreductionisms

The second important feature is that the centrepiece of Critical Neuroscience is probably to be found in the philosophical and theoretical engagement with various forms of reductionism. At the heart of this is a concern with, and debate about the reductionism that has become endemic in neuroscientific research (Stadler 2012: 4726). Some of these concerns are clearly expressed in the first three features of Rose's (2012) tasks for critical neuroscience:

> First, it needs to analyze and make transparent the metatheoretical and ideological underpinning of the current neuroscientific enterprise. Second, it needs to scrupulously unpick the empirical claims made by neuroscientists offering to 'explain' memory, intelligence, love, or consciousness and to 'locate' them in specific brain sites, neuronal ensembles, or molecular processes. Third—and this is the harder part—it needs to offer a credible alternative to the 'ruthless reductionism' that dominates neuroscientific thought and practice, without collapsing into what Richard Dawkins once memorably referred to as a 'holistier than thou' rejection of what reductionism has to offer.

Admitting that methodological reductionism — that is, reducing complex phenomena to their component parts, or simply equating a part with a whole — is one of the most successful research strategies used by scientists to understand the world (see Kirmayer & Gold 2012, Rose 2012) does not mean that it should blindly be endorsed. In fact, it is now recognised that it should be supplemented by approaches that emphasise the role of context (see Murphy & Brown 2007: 47). The main issue is that, in neuroscience, reductionism becomes an end in itself when neurobiology and molecular biology disregard the complex phenomena that enmesh things. Ramachandran (2011) illustrates the problem with the example of dissecting the testes and even performing a molecular analysis which, according to him, cannot explain what sperm is without understanding sex. While accepting the importance of including the brain and neuro-research in understanding the human condition, Critical Neuroscience seeks to avoid the overconfidence in the new neurobiologism by providing discursive space for critical engagement with (experimental) neuroscientific research and its social and cultural situatedness:

"A critical theory must thus examine the metaphysical and ideological context in which such reductionism has become the dominant mode within neuroscience" (Rose 2012).

The main form of reductionism in neuroscience (with far-reaching consequences) is of an ontological nature: higher level entities are viewed as nothing but the sum of their parts (see Murphy & Brown 2007: 47); in this view, mental states are reduced to brain states (Rose & Abi-Rached 2013: 20); mind or consciousness is regarded as an epiphenomenon of brain (Fuchs 2002, Rose 2012); experience is merely an epiphenomenon of neural activity (Kirmayer & Gold 2012), and mental disorders are epiphenomena of defected brain processes (Fuchs 2012: 9681). This reductionism also entertains a unidirectional and linear causality model (Kirmayer & Gold 2012), where lower parts of a system are determinative of higher level entities such as the view that entities on the atomic, molecular or cellular levels determine higher functions.

Reductionism, in its variety of forms, is a key issue in neuroscientific research that deserves to be explored fundamentally in the Critical Neuroscience enterprise (Murphy 2003). Ontological reductionism, referred to as neurobiologism or simply as neuroreductionism, is challenged by an integrated understanding of the brain as embodied. Instead of the reductionism displayed in the neurobiologism, the ontology of Critical Neuroscience is informed by the '4EA approach' (Choudhury & Slaby 2012) which views the mind as embodied, embedded, enacted, extended, and affective. Fuchs (2009: 221) calls this the "ecological view of the mind and the brain [italics original]". In the words of Menary (2010: 462), it assumes "a multidimensional analysis of cognition as incorporating our brains, bodies and environments". The implication is that, in order to understand the brain, it is necessary for neuroscience to genuinely become a human and humane science (see Rose & Abi-Rached 2013: 234).

The notion of "complex adaptive systems", as presented by Murphy & Brown (2007: 85), serves as an example of the reconceptualisation that is taking place in the face of neuroreductionism. In this view, the brain is part of, and entangled in different networks and systems within which it operates. Therefore, the counter-ontology of Critical Neuroscience resonates with the 4EA view, "which assumes that mental processes are understood as constitutively embodied and environmentally embedded such that they cannot be properly characterized without reference to their bodily dimensions and relations to the physical and social environment" (Choudhury & Slaby 2012). Fuchs (2009: 228) describes this view of the brain by means of the metaphor of the brain as an organ of translation or transformation:

> Thus, the brain is an organ of transformation of configurations of single elements into higher level units corresponding to our perceptions or actions. By this, it becomes the organ of mediation between the microscopic world of material or physiological processes on the one hand, and the macroscopic world of the living organism and its experiences on the other hand. By integrating elementary processes into higher-order patterns, it enables the living being to relate to the world by perceiving and acting.

This ontology entertains a circular feedback and mutual causality systems model. A feature of such a model is that it displays a wide range of emergent phenomena that are not obvious from the rules that govern the interaction of the components (see Kirmayer & Gold 2012). Consequently, neuroscientific analysis takes place at various interlocking levels, or by means of the circular causality found in living systems as complex systems (see Fuchs 2012: 9685). As an emerging perspective, Critical Neuroscience, for example, explores metaphors such as the notions of the 'situated brain' and of 'cultural biology' which emphasises the "co-constitutive relationship between brain and context" (Slaby & Choudhury 2012) and Fuchs's (2009: 228) notion of "biographical biology" in the search for conceptual vocabularies and interpretive frameworks which can provide operational space for this enterprise. Fuchs (2009: 228) explains this concept as follows:

> A 'biographical biology' implies the continuous formation and reconstruction of the brain via subjective experience. The mind works to constrain or structure the lower-level properties of the brain and the body: it consists mainly in forming and maintaining meaningful units of experience which stabilize corresponding neuronal activity patterns and thus trigger, accordingly, physiological reactions of the organism as a whole. In this complementary relationship there is nothing like 'a mind acting on a physical body' nor 'a brain producing the mind'. Instead, the brain acts as a transformer which may be addressed through input on different hierarchical levels and which translates in both directions: psychosocial influences on the level of meaning and intentionality are transformed into altered patterns of neuronal activity on the biological level, and vice versa. This means that any process concerning the aetiology and symptoms of mental illness is of a biological as well as a psychological nature.

One more consequence, or rather, extension of the potential reductionism in the neurosciences should be highlighted, namely that of conceptual reductionism. One of the simple truths about neuroscience is that there is no

unified theory about the brain and agreed definitions of common terms such as memory or consciousness (Rose 2012, Alivisatos et al. 2012). Consequently, on the level of concepts, Rose illustrates that what neuroscientists do when investigating consciousness is to strip it of its richer meanings in order to be restricted to awareness or perception only. Conceptual reductionism is nowhere more apparent than in claims about brain-imaging studies (Gallagher 2012, Rose 2012). Not only elaborate claims about brain-scanning research, but also many critical discussions about its shortcomings are currently prevalent. These include problems with what such scans actually display and the actual resolution of pictures obtained to problems with statistical analyses and inference techniques.[3] The potential to avoid the problems is to be found in interdisciplinary collaborations (Cacioppo et al. 2003: 659). Therefore, critical engagement in (experimental) neuroscience can "enrich conceptual vocabularies" of the phenomena being studied (Slaby & Choudhury 2012). Or, as recommended by Raz (2012: 7991), "[c]ritical neuroscience must offer constructive ways to address — rather than carp about — the inherent shortcomings of neuroimaging research".

From a South African perspective, several elements of the neuroreductionism debate can be engaged in a critical way. For example, given the importance of neuroscientific research in the current scientific milieu, the issue of conceptual reductionism offers an opportunity for reflection about the terms and conceptualisations such as 'mind' and 'consciousness' used in mainstream neuroscience research. Turner (2012: 5), for example, points out that many European languages have no term that covers precisely the range of meanings that 'mind' does. For example, in German, 'mind' is translated as Geist or Verstand, while Geist also means spirit, ghost, and wit, and Verstehen also means reason. This raises the question as to whether 'mind' is not a language-specific designator that predisposes neuroscientific research into a particular framework of thinking. This research tradition can probably be enriched by the critical engagement with local notions about the nature of being human and ideas on the human self.

2.3 Critical Neuroscience and the thickening of discursive practices

The anthropologist Webb Keane (2003: 222) remarks that a feature of many ethnographically oriented approaches to culture and society is the following: "We need to complicate the story". Critical Neuroscience strives to do this, not only in avoiding reductionism, but also by being culturally sensitive and phenomenologically aware in paying attention to lived lives. It seeks to be a truly human science.

3 Cacioppo et al. 2003, Spezio 2011, Raz 2012, Margulies 2012.

As indicated earlier, Critical Neuroscience works in at least two directions: to improve experimental neuroscientific research and to import in a responsible way neuroscientific research and results into discursive practices about human thought and action (see Kirmayer 2012: 370). Both directions will briefly be considered.

2.3.1 Critical engagement with experimental neuroscience

As expressed by Choudhury et al. (2009: 66), the motivation for Critical Neuroscience is "in the service of maintaining good neuroscience, improving representations of neuroscience, and creating an awareness of its social and historical context in order to assess its implications". Or, as explained by Chiao & Cheon (2012), "by studying cultural values, practices, and beliefs at a neural level, we gain leverage on understanding how cultural context affects normal brain functioning in the laboratory setting". This can be done in many different ways. For example, Critical Neuroscience thickens discursive practices concerning neuroscientific activities by including the social and political dimensions of research activities.

One way in which this is done is by investigating how environmental factors and culture impact on neural processes, as is done by social and cultural neuroscience (Choudhury & Slaby 2012). Cultural neuroscience, in particular,

> is motivated by two intriguing questions of human nature: how do cultural traits (such as values, beliefs, and practices) shape neurobiology (for example, genetic and neural processes) and behavior? And how do neurobiological mechanisms (for example, genetic and neural processes) facilitate the emergence and transmission of cultural traits? (Chiao & Cheon 2012: 8489).

As a subdiscipline ascribing to the extended ontology of Critical Neuroscience, cultural neuroscience "aims to explain a given mental phenomenon in terms of a synergistic product of mental, neural, and genetic events" (Chiao & Cheon 2012: 8500). Without access to brain-scanning equipment, South African scholars can contribute a great deal to this project by analysing cultural phenomena such as notions of the self, beliefs about angels and ancestors, or practices such as exorcisms and witchcraft, as configurations of complex human phenomena in which neural features play a significant role. A neural understanding of aspects of human nature and culture broadens rather than constricts our sense of who we are as human beings (LeDoux 2003: 303). The neuroscientific perspective does not aim to replace other discourses, but to enrich and enhance them.

Another way in which discursive practices can be thickened is by taking seriously the social, anthropological and historical record in doing neuroscience. It is, for example, known that, within the field of psychology, 96% of psychological samples come from countries with only 12% of the world's population (Henrich et al. 2010: 63). Similarly, within the field of human neuro-imaging, 90% of peer-reviewed neuro-imaging studies come from Western countries (Chiao & Cheon 2012: 8477). Therefore, in the words of Chiao & Cheon (2012: 8472), Critical Neuroscience

> alerts us to a shift in the behavioral and brain sciences [...] whereby a richer awareness of the social, cultural, economic, or political context surrounding normal scientific practices in the behavioral and brain sciences may be the key to developing a deeper and more complete understanding of the human mind and brain.

Critical participation by, and involvement with neuroscientific research from an African cultural and social location seems an obvious challenge. The cultural laboratory of Africa offers an alternative one from that dominated by the study of the Western Educated, Industrialized, Rich, and Democratic (WEIRD) people — the most common test subjects in cognitive and neurosciences (see Henrich et al. 2010: 62). As indicated, they constitute by far the majority of test subjects and, in many instances, also represent the exception to any human universal — in so far as a majority points towards a universal tendency. It should remain an ideal for South African and African scholars to participate in experimental neuroscientific research if only to correct this imbalance.

2.3.2 The impact of neuro-matters on human affairs

Rose's (2012) fourth and fifth tasks for Critical Neuroscience are that it needs

> to work to help integrate neuroscientific understandings into the many rich and varied discourses on human thought and action and [...] to keep a very wary eye on the developing neurotechnologies with their power to intrude and intervene in the fundamental processes and freedoms of civil society.

Both tasks point towards the very wide impact of neuro-matters on human life.

New neurotechnologies and insights into the working of the brain provide a challenge and new opportunities. Almost on a daily basis there are novel discoveries and inventions in neurotechnologies that did not exist yesteryear. For example, it is self-evident today that without a brain there is no self. What is not self-evident is in which way the working of the human brain contributes to the

making (or unmaking) of the self. A considerable body of neuroscientific research is advancing new debates and avenues on the age-old question about the 'self' and the more recent debate about consciousness. From the neurosciences, this is best illustrated by means of aspects of the self that disappear or cease to function when certain brain functions are affected. A case in point is the Capgras syndrome where patients can see familiar faces, but are unable to recognise them and consequently call them imposters. The self is deranged when family members are not recognised; this is the result of a disjunction between the visual and emotional processes in the brain (see Ramachandran 2004: 7-9, 90). Another example is referred to as apotemnophilia where someone is convinced an arm (more often than not, the left arm) does not belong and needs to be amputated. A mismatch between the body image in the brain and the physical body results in a disturbed self-consciousness, because a vital sense of self is the feeling of inhabiting one's own body (see Ramachandran 2011: 5018). Therefore, discourses about selfhood and what it is to be human are increasingly being informed (or transformed) by brain-based research. Numerous recent studies on the 'self' already point towards the importance, if not impact, of neuroscientific research on reflection about the self (Fuchs et al. 2010, Van Huysteen & Wiebe 2011).

Critical Neuroscience can enrich research conducted in such programmes by opening new avenues for interdisciplinary research and collaboration. This can take place within the domain of neuropsychiatry, as indicated earlier, but also in understanding cultural and religious beliefs and practices as configurations of basic human neurocognitive and neurocultural potentialities. This can take place, as indicated, in the search for the self, because traditionally notions of the self (as soul or spirit or consciousness) dominate religious and cultural traditions. Very few religious and cultural traditions can be divorced from the role of self-concepts and notions of afterlife that accompany them. Since neuroscientific research is impacting on debates about the self, it will most certainly influence received views on the self (or soul). This is already evident in the numerous international publications on the interconnectedness between self or soul concepts and, for example, out-of-body and near-death experiences (see Marsh 2010, Engmann 2014). The revolution in the neurosciences is likely to impact, challenge and, where necessary, alter some of the cherished religious and cultural notions about human life in general, and Critical Neuroscience offers an interdisciplinary tool for bringing neuroscientific and various other disciplines (for instance, religious and anthropological studies, psychology and others) together in a new collaborative enterprise. This is not a plea for a new neuro-discipline, but an apology for exploring the great potential of interdisciplinary neuroscientific research via the tools of Critical Neuroscience. The interconnectedness between religious

and cultural ideas about the human self and brain-based experiences (such as, out-of-body experiences) demands critical reflection in a South African context.

There is an ironic twist to this tale, because Vidal argues that criticism should also be directed at neuroscience itself and the cultural notions that place the brain at the centre of self-reflection. In a cultural critical analysis of the current neuro-hype, Vidal (2009: 7) argues that the "idea that 'we are our brains' is not a corollary of neuroscientific advances, but a prerequisite of neuroscientific investigation". He shows that the idea of selfhood as reduced to brainhood is a unique Western phenomenon of modernity. No other culture "has proposed the reducibility of self to an organ of the body", and this process started already in the seventeenth century (Vidal 2009: 11). Be that as it may, it again highlights that we live, not only scientifically, but also culturally, in the era of the brain. Things 'neuro' are important and significant and should remain at the centre of critical reflection. On the one hand, engagement with these debates about what it is to be human and to have or be a self/consciousness is essential. Given the impact of such ideas on individuals and society, these are necessary debates. On the other hand, a critical examination of these discourses needs to be conducted. At the same time, some clues as to the very processes that constitute self or 'mind' itself might be found in the culturally diverse ways of constituting selfhood. Briefly, neuroscientific research is contributing to the enterprise of reshaping the ways in which we think about ourselves, others, our social relations and our ethical values and commitments. Since notions about ourselves and the self are central to our understanding of what it is to be human, research that influences such ideas goes to the heart of, or at least influences how we raise our children, run our schools, organise our societies and structure social policies, how we treat those who commit crimes or are deemed mentally ill, those who are terminally ill or arrive in the world unplanned, how we think about life and death and how we treat animals and our fellow human beings (see Rose & Abi-Rached 2013: 1, 202). In a country faced with innumerable social problems, of which racism and social identity are two examples, critical discourses that go beyond the social (labelling) or the political (power) levels of constructing ourselves and others can only benefit from the tools of Critical Neuroscience which add interpretive mechanisms to think about the ways in which we are human.

3. Concluding remarks

This brief overview of Critical Neuroscience as an interdisciplinary gaze and space should suffice to support the claim that neuroscience research is not only growing exponentially, but also impacts on science and society — it impacts on numerous disciplinary/scientific activities and simultaneously affects central issues in society

(such as selfhood). Its broad and open-ended agenda serves as an invitation, in the South African (and African) context, to engage neuro-matters more diligently and over a much wider spectrum than has been the case in the medical and pathological settings of neuroscience at medical schools. Critical neuroscientific research is a way of looking at the human condition, where the central role of the brain is acknowledged in determining, or at least influencing, the ways in which we think about humanity.

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