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Brainbodies and the Imaging of Plasticity

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Title: *Brainbodies* and the Imaging of Plasticity

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Abstract

This article considers two conceptual formations – *brainbodies* and plasticity – through some of the image-form processes of neuroscience, art and curation. Underpinned by the writings of philosopher Catherine Malabou, the ethnography of Science and Technology Studies (STS) scholar Joseph Dumit, and the artistic projects of curator Carolyn Christov-Bakargiev, the article firstly examines Positron Emission Tomography (PET) (as articulated by Dumit) and its image-making processes to show how plasticity is at work in the *brainbody*'s molecular negotiations with the scanning apparatus. Secondly, the article analyzes the entanglements generated out of the receptions of neuro-aesthetic and artistic image-forms in the curatorial directions of two of Carolyn Christov-Bakargiev's projects: *dOCUMENTA (13)* and the 14th Istanbul Biennial *SALTWATER: A Theory of Thought Forms*. A diffractive methodology of reading, as articulated in the feminist techno-scientific writings of Donna Haraway and Karen Barad, helps to re-register the plasticity of matter in the contexts of art and curation. The image-forms that feature in this article expose some of the boundaries and limitations of cultural meaning-making and their associated forms. This includes the productive insights generated out of the crossing through of disciplinary perspectives and their image-making mechanisms.

Keywords

Brainbodies, plasticity, image-forms, neuroscience, art, curation

Introduction¹

Brain scanning technologies are image producers. In the 1980s and 1990s two functional imaging technologies in particular – fMRI (functional Magnetic Resonance Imaging) and PET (Positron Emission Tomography) – were designed to better access brain properties through the technics of the neuro-image. These apparatuses of image production have contributed to a value system in the world of neuroscience where the brain scan acts as the evidence base for the enactments, performances and lived experiences of mental life (see Choudhury et al, 2009; Choudhury, 2011), including differences between typical and atypical forms of behaviour (see Pitts-Taylor, 2010, Dunagan, 2010, Thornton, 2011, Fitsch, 2012, Rose, 2014).

Feminist scientist Sigrid Schmitz and sociologist Grit Höppner discuss how ‘neuro-materiality’ provides an opening into neurofeminist debates about the brain’s entanglement with ‘bodies, mind, behavior, socio-cultural contexts, and meaning-making’ (Schmitz and Höppner, 2014, 546). They explain how ‘brain images are snapshots of a certain moment of physical materiality, which is always connected to individual biographies’ and that brain scans in and of themselves cannot ‘provide information on the processes that led to these developments, neither from nature nor from culture’ (Schmitz and Höppner, 2014, 546). The brain image, as produced by these mechanisms, thus seems distanced from what *brainbodies* are as entangled agencies in the world. And yet, the PET or fMRI scan has come to *inform* the

¹ This article has evolved out of the 7th Annual Conference on New Materialisms, organized by the European Cooperation in Science and Technology (COST Action IS 1307 Networking European Scholarship ‘How Matter Comes to Matter’). The conference, held in Warsaw in 2016, sought to revisit Donna Haraway’s ‘Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective’ (1988). As a participant in the workshop ‘Process of Imaging/Imaging of Processes’, organized and led by Liv Hausken, Bettina Papenburg and Sigrid Schmitz, I proposed to consider the contexts of neuroscience, art and curation, out of which certain images of *brainbody* phenomena are formed.

semantics of life forms: the technologies of brain imaging are part of a constellation of entanglements that attach certain meanings to neuronal activity, including the historical and cultural registrations of our mental lives.

This article proposes to work with the conceptual formation *brainbody* and its function as a formal signifier for the ongoing relations between 'brain' and 'body' in and through situated and shifting processes of becoming, or, with reference to the language of plasticity, in and through processes of material transformation and inevitable change. Brains are bound to minds and bodies inside a constellation of histories, cultures and contexts. The particularities of the *brainbody's* own biographical history, as a thinking mind shaped by experience as a body-in-the-world, are entangled with the conceptual schemes of neuronal imaging and neuroplasticity. Derived from the Greek *plassein* 'to mould or form', and registering the transformation of materials, from the molecular to the digital, the psychic to the aesthetic, the term 'plasticity' is often used in current discourses (across a range of disciplines) to describe neurological and mental states of change. Plasticity is thus a carrier of different material capabilities and ideological form-evocations. It can hold shape and be reshaped. It is fluid and it travels. For the philosopher Catherine Malabou in *What Should We Do with Our Brain?* (2008), the registrations of brain plasticity extend to acts of modelling, modifying, altering and annihilating the forms of our lived experience. For example, 'developmental plasticity', 'modulational plasticity' and 'reparative plasticity' constitute a cerebral system shaped out of the brain's engagement in and of the world:

[...] there are not just *one* but *many* plasticities of cerebral functioning. The interaction of these plastic modalities sketches an organization that does not at all correspond to

traditional representations of the brain as a machine without autonomy, without suppleness, without becoming – representations that today have become true “epistemological obstacles”. It is urgent that we affirm, against these representations, which no longer represent anything at all, that our brain is in part essentially *what we do with it*. Individual experience opens up, in the program itself, a dimension usually taken to be the very antithesis of a program: the historical dimension. (Malabou, 2008, 29-30)

In this respect, engagement with plasticity in the contexts of the *brainbody*, draws upon differing semantic registrations, including the historical dimension, and with it, questions about the neuronal and mental entanglements at work in the fashioning of image-forms. By ‘image-form’ I refer to the visible shapes and configurations of material phenomena and the ways in which they come into appearance through certain mechanisms and practices of image-making. Within the context of this article, convergences between the processes of brain imaging and artistic matterings of the *brainbody* will be explored through two specific examples and/or situations; one emerging out of a neuroimaging context, and the other operating at the point of mutual entanglement between neuronal phenomena and the psychic tendencies of mental image production. As conceptual formations, these examples provide opportunity to re-consider how *brainbody* activity and the form dimensions of plasticity are part of a mutual system of cultural and historical relations in neuroscience, curation and art.

Re-situating knowledges in and through the practices of neuroscience, art and curation

The feminist and cultural theorist Donna Haraway outlines the premise of the ‘partial

perspective' in her 1988 text 'Situated Knowledges: The Science Question in Feminism and the Privilege of the Partial Perspective'. She writes:

Situated knowledges are about communities, not about isolated individuals. The only way to find a larger vision is to be somewhere in particular. The science question in feminism is about objectivity as positioned rationality. Its images are not the products of escape and transcendence of limits (the view from above) but the joining of partial views and halting voices into a collective subject position that promises a vision of the means of ongoing finite embodiment, of living within limits and contradictions – of views from somewhere. (Haraway, 1988, 589-590)

Thinking with and through material, aesthetic and scientific cultures, their imaging processes, both techno-scientific and artistic, *and* their meaning-making strategies, re-engages the apparatuses of neuroscience and image-making tools through the diffractive lens of semantic differences. Situated and partial perspectives embedded within the contexts of art and curation provide new ways to think about *brainbody* plasticity. In *Modest-Witness@Second-Millennium FemaleMan_Meets_OncoMouse: Feminism and Technoscience* Haraway elaborates on the semantic language of feminist technoscience that emerged in the 1990s and her motivations for reading the technoscientific body as an emergence within a field of differentiating knowledges:

Objects like the fetus, chip/computer, gene, race, ecosystem, brain, database, and bomb are stem cells of the technoscientific body. Each of these curious objects is a recent construct or material-semiotic "object of knowledge," forged by

heterogeneous practices in the furnaces of technoscience. [...] I am committed to showing how each of these stem cells is a knot of knowledge-making practices, industry and commerce, popular culture, social struggles, psychoanalytic formations, bodily histories, human and nonhuman actions, local and global flows, inherited narratives, new stories, syncretic technical/cultural processes, and more. (Haraway, 1997, 129)

To read diffractively requires engagement with the ‘material-semiotic’ registrations of phenomena, to track how they take hold and acquire cultural currency across a range of practices. As Haraway suggests, the technoscientific body is made up of a complex syntactic entanglement where the science of semiotics moves its way through different figurations. Moreover, conceptual formations are constructs shaped and reshaped, in turn, by the technoscientific body. In this respect, *brainbodies* carry many literacies. For example, they are not just an extension of the phenomena of brain science. This provides opportunities to further make sense of ‘the physiology of meaning-making’ (Haraway, 1997, 14), as well as to track how image-forms travel into other spaces and places. As theoretical physicist and feminist theorist Karen Barad explains in an interview with new materialist philosophers Rick Dolphijn and Iris van der Tuin, a diffractive methodology reads:

[...] insights through one another, building new insights, and attentively and carefully reading for differences that matter in their fine details, together with the recognition that there intrinsic to this analysis is an ethics that is not predicated on externality but rather entanglement. Diffractive readings bring inventive provocations; they are good to think with. (Barad, 2012)

The 'knot of knowledge-making practices' (Haraway, 1997, 129) I want to think through is embedded within the cultures of neuroscience, art and curation. The material entanglements of form and plasticity give rise to image-forms emerging from within a field of semantic differences. Reading as a mode of 'mattering' allows reconfigurations to take place: by seeking out differential patterns in entangled spaces, acts of formation are re-considered from *within* the apparatuses of image-form production. This includes the contexts these forms enter into and/or are continuously re-shaped out of. The semantic plurality of plasticity is integral to the technoscientific processes and practices of image-form making.

Image-Form 1: form annihilation as a phenomenon of the *Brainbody*

My first example considers the PET scanning apparatus and the mediations of brain imagery into culture. The sociologist Hannah Fitsch has written about the ways in which brain imaging visualizations are displayed and transferred. She analyzes the historical shifts embedded within brain images, preconceived modes of perception within the network of science, art and technologies, including the regimes that make them 'seeable' and 'readable'. Fitsch writes:

Imaging technologies have a history that matters to what they make visible. The statistic maps of fMRI are not pictures of the original brain but visualized knowledge of a normative and categorizing regime. Hence, aesthetics as the structure that defines the displaying modes as well as what can be made visible and seen at all, is part of this regime. Within this meaning of aesthetics the concept is always already an ethical project. (Fitsch, 2012, 282)

Rather than pursuing this line of enquiry, which Fitch succinctly accounts for in her reading of the brain scan image and its coded discourses of legibility and illegibility, I am instead focusing in on how we might, through diffractive readings, re-stage certain scientific discrepancies as artistic meaning-making image-forms. For example, the codification of brain imagery is reliant upon the communities of expertise deployed to give shape to it – information derived from the worlds of physics, computer science, mathematics, neurology and pharmacology – so much so that the interpretation of the brain as a visualization of complex technological processes and practices is carried into culture to be read and understood in particular codified ways.

For feminist neuroscience, brain plasticity has helped to critique certain biological determinisms, e.g. of gender, race and other social categories, including the internal mechanisms and structures of information derived from the apparatuses of brain scanning. The mechanisms of exchange between the biomaterialities of the body (as an information system) and the meaning-making practices of mind (as an intermediary between *brainbodies* and environments) have generated new entanglements between phenomena. Re-reading the brain imaging process itself, with the technoscientific body in mind (as understood by Haraway) and the reception, production and annihilation of form (as understood by Malabou), discloses relations brain scanning apparatuses and *brainbodies*.

i. Re-reading Dumit's reading of PET scanning

Joseph Dumit's studies into the communities that generate scientific images provide useful accounts of the processes of Positron Emission Tomography (PET). In *Picturing Personhood: Brain Scans and Biomedical Identity* (2004) Dumit discloses phenomena intra-acting with the

apparatuses of scanning. As he explains, any brain-and/or-body that undergoes a PET scan receives a radiotracer injection, a positron emitter which is essentially a form of radioactivity produced by a defined set of isotopes which are used to observe metabolic processes:

These positron emitters, however, include carbon-12, oxygen-15, nitrogen-13, and fluorine-18. Carbon, oxygen, nitrogen, and hydrogen are the basic building block atoms of life. Because fluorine can substitute for hydrogen atoms in molecules, almost any molecule of significance for studying the brain can be made radioactive and its activity can be tracked in a PET scanner.² (Dumit, 2004, 69)

What this means is the radiotracer acts *as if* it were a regular molecule but flows through the *brainbody* emitting radioactivity in the form of positrons. These positively charged electrons collide with other electrons, and out of their explosion and annihilation, gamma rays are captured by crystals and light detectors within the scanner. This process relies on the biological make-up of the *brainbody* and its different molecular compounds including their physical and chemical transformations in neuronal activity. As Dumit explains, ‘because the tracer is what is emitting radioactivity, an image of “brain activity” is really an image of glucose consumption, oxygen flow, Prozac flow, and so on’ (Dumit, 2004, 71). The brain image is derived from the coordination and collision of molecular compounds with a surveillance mechanism – the tracer. What is traceable by the PET scanner is the impact of the annihilation of neutrons. It is the gamma rays that provide the stimulus for the transformation of these

² Dumit also notes: ‘These positron emitters have relatively short half-lives, meaning that they do not stay radioactive in the body too long (unlike carbon-14, which lasts for centuries).’ (Dumit, 2004, 69)

neutrons into data. In this respect, the *brainbody*, whilst both receiving and producing ‘form’ from out of its intra-action with the technological apparatus of the scanner, is also the generator of annihilation: the very explosion needed to generate data, which in turn, through a series of procedures, is eventually visualized as a brain image. As Dumit suggests, this post-processual activity is about creating a dataset for analysis with other datasets.

The production of a brain image as a ‘conceptual object’ with measurability (as opposed to conceptual formation) engages the so-called organic brain within a three-dimensional space (the scanner that gathers and compartmentalizes data) and is, according to Dumit ‘analogous to the cognitive neuroscience assumption that the brain itself is analyzable into separate module-like components that are differentially active in a state-like manner. The PET apparatus builds these neuroscience assumptions into its architecture and thus can *appear* to confirm them, while necessarily reinforcing them’ (Dumit, 2004, 80-81). The brain image as a conceptual and measurable ‘object’ has to be *readable*, that is, it must adhere to the codes, conventions, orderings and assemblages of a shared language, in order for it to be analyzed, understood, disseminated and situated within the neuroscientific community. Without *readability*, the conceptual object does not belong. If it does not belong, it cannot be measured.

Dumit’s extensive ethnographic research addresses how the biological brain is transformed into a ‘*brainset*’ or ‘atlas’ as soon as it is scanned. His account provides a way to understand brain image production from out of the physiological enactments that make this imaging process possible. The PET scan process is a mode of image-making that reveals the strange interdependencies between the technological apparatus and the *brainbody*. This scanning

procedure reveals the plastic transformations of our own *brainbodies* and the limits imposed upon them through conceptual objectification processes. As Schmitz (2016) argues, when we consider *brainbodies* as an entire system and in the contexts of plasticity, we do not simply reside within the spaces of ‘biomaterial dynamics’. She writes:

Agential changes in network connections, neuronal and synaptic reorganizations, variations in signal processing, and transmitter regulation as well as changes in inter- and intra-cellular molecular processes down to gene regulations always intra-act with unconscious and conscious experiences, information from the environment, meaning-making and constitute new forms of *information*. In this perspective, neither the brain’s materiality nor the conscious mind can be conceptualized as a passive recipient or pure actor. It is their agential convergence that constitutes behavior and communication. (Schmitz, 2016, 149-150)

In this respect, what might it mean to read the *brainbody*’s reaction to the radiotracer as an agential creative force? In chapter three of *What Shall We Do with Our Brain*, Malabou revisits the onto-epistemological discrepancies between neuronal and mental articulations of brain phenomena. With reference to Joseph Le Doux’s *Synaptic Self*, the basic premise of which situates the ‘self’ as a system of synaptic connections and pathways in, with and through the biological, physiological, psychological, social and cultural connections that make up the brain as a living organism, Malabou considers how ‘the “self” is a synthesis of all the plastic processes at work in the brain’ (Malabou, 2008, 59). Antonio Damasio calls this the ‘proto-self’ situating it as a kind of ‘preconscious biological precedent’ for autobiographical consciousness (Damasio, 1999, 174). These organic foundations (‘the state of the internal

milieu, viscera, vestibular system, musculoskeletal frame') and their 'nonconscious processes' serve as the condition of possibility for making thinking consciousness possible, and with it, the production of mental formations in the mind (Malabou, 2008, 60). This in turn, generates a sense of 'core self' or 'autobiographical self' (Damasio, 1999, 22), a conscious representation of the nonconscious processes of *brainbody* phenomena. Malabou discusses how this representational play does not demarcate a dividing line between neuronal patterns and mental patterns, but rather allows for a blurring of the two territories. She writes:

The transition from the neuronal to the mental is confirmed by the fact that it is impossible to distinguish the two domains rigorously and absolutely. If, in effect, there is a subterranean representational activity in the brain, this already signifies that neurons, through "being in connection" are already available for, and already disposed toward, meaning. In the same way, meaning, or symbolic activity in general, depends strictly on neuronal connectivity. (Malabou, 2008, 61-62)

One can start to see how the neuronal and the mental are at work in the registrations of molecular activity in the *brainbody's* engagement with the PET scanning apparatus. For example, the PET scanner must pass through a mediation process, where molecular form annihilation constitutes the form of the brain image. In other words, the physiological activity of the *brainbody* in the PET scanner, as much as receiver of the apparatus for image production, is also agent of annihilation. The *brainbody's* critical negotiation with the PET scanner as a 'neuronal' apparatus helps to problematize the 'conceptual object' derived from neuroscientific modes of image-making. That which is not yet formed (the brain image) is generated from out of molecular explosions. The collision of electrons with electrons inside

the scanner produces a detectable explosion. It is the *brainbody's* ability to charge at radioactive positrons that initiates a plastic transformation. Rather than read the neuroscientific process as simply 'what happens' I am suggesting that the processes that enable image formations are part of the 'subterranean representational activity' of the *brainbody* as an organic system actively giving place to the generation of meaning (the mental reconstructions of an image). As Malabou explains:

This internal power of representation inherent in neuronal activity constitutes the prototypical form of symbolic activity. Everything happens as if the very connectivity of the connections – their structure of reference, in other words, their semiotic nature in general – represents itself, "maps" itself, and precisely this representational activity permits a blurring of the borders between brain and psyche. (Malabou, 2008, 60)

A re-reading of the molecular registrations of *brainbody* activity tells us much about the plastic production, reception and annihilation of phenomena in the processes of image-making, including the entry of these images into culture. If molecular form annihilation is that which gives place to the very transformation of the neuronal biological brain into a 'conceptual object' (Dumit's term), then we are also confronted with the possibility that *this* mental construct (derived from the tools of the apparatus) is both a particular imaging of molecular processes and carrier of meaning: the coming into consciousness of nonconscious processes. A diffractive reading *into* the neuronal and mental articulations of brain phenomena helps to redeploy the multiple semantic dimensions to plasticity – aesthetic, ethical, political and social – so as to draw out and create alternative spaces and conceptual formations for thinking about *brainbodies* and what they perform.

ii. Cultural appropriation and plasticity's resistance

Malabou's philosophical reading of the multiple and intertwined registers that make up the semantic receptions of plasticity, includes an agential power that resists the co-opting of plasticity with neoliberal registrations – such as 'flexibility' – and their ideological formations. Ever changing states of 'self-formation', in a culture of shifting identities, means that the circularities of becoming are preoccupied by ongoing acts of 'fashioning' and 'refashioning', both in response to neo-liberal demands *and* as acts of self-initiated and quasi-autonomous change. The idea that plasticity is central to the brain's ability to reshape itself has entered into popular discourse through certain neoliberal economic demands. This premises the 'healthy' functioning of the brain over other semantic registrations. For example, communications theorist David Johnson Thornton (2011) explains how the dissemination of neuroscientific discourse into media and popular culture has contributed to a growing language of popular neuroscience, where mobility, fluidity, variability and adaptability now feature in common parlance. She suggests that the 'mutual influence between brain culture and neoliberal culture' is one of shared languages (and literacies) and that this impacts on how lives are lived: 'the ways we understand the brain directly feed into and enable the ways we organize and practice our political and economic worlds. (Thornton, 2011, 63). Neoliberal capitalism for example uses popular discourses on brain plasticity to reinforce the ideologies of market enterprise. The term 'flexible labour' thus re-purposes the malleability of brain plasticity into a form aligned to neo-liberal interests. By extension, the artist Warren Neidich (2016) discusses how the changing mechanisms of neural plasticity have led to the continuous emergence of imagery 'transmitted and embedded in cultural forms of representation' (Neidich, 2006, 228). The development of new technologies of image production are thus

inextricably linked to new modes of 'cultural binding' (Neidich) as part of neuro-governing paradigms in western culture.

As a semantic wealth (and to some extent evolving assemblage of partial perspectives) plasticity travels into different contexts. It both embeds and situates, is embedded and situated. Its many forms are thus part of the meaning-making apparatuses that produce, receive and sometimes eradicate the aesthetic, ethical, political and social cultures of plasticity. As Malabou suggests, we must hang onto the idea that plasticity is a concept which is not 'contradictory' but 'graduated', because its meanings are part of material-creative processes where form is constantly transformed by new sites and situations. In this respect, we should embrace plasticity's potential as a 'resource of giving form, the power to create, to invent or even to erase an impression, the power to style' (Malabou, 2008, 12). This also includes the annihilation of form as a register of plasticity's potential to undermine the forms it receives *and* produces. As an agential force able to take on and produce form (as in the fashioning of matter), plasticity is also explosive in its power to act as 'an agency of disobedience to every constituted form, a refusal to submit to a model' (Malabou, 2008, 6).

Whilst the cultural appropriations of plasticity are often assigned to the ideological processes that underpin governing paradigms of neoliberalism, might not the reactions of the *brainbody* (inside this particular neuro-techno-scientific context) tell us something about form resistances to the mechanisms and/or regimes of normativity and categorization? When we read through neuroimaging production processes and discover that form annihilation is actually the condition of possibility for image-making, we are also exposed to the mutual relations at work in neuronal *and* mental ways of seeing and thinking, including their plastic

potential to critically negotiate and resist the forms they simultaneously produce. Brain imagery is more than a mere mirror of, and receptacle for, neoliberal economic agendas. In this respect, form annihilation is part of the *brainbody*'s own 'physiology of meaning-making' (Haraway, 1997, 14) as well as 'an agency of disobedience to every constituted form' (Malabou, 2008, 6). This conceptual formation requires that we remain alert to the physiological and psychic agencies of *brainbodies* in culture in addition to more established and embedded neurological registrations.

Image-Form 2: producing and receiving artistic forms

In *The Brain's Body: Neuroscience and Corporeal Politics* (2016) feminist and critical theorist Victoria Pitts-Taylor accounts for the brain's body as 'an assemblage model of the embodied mind' and its disciplinary types. This allows for 'ethico-onto-epistemological' implications to be raised and addressed through the 'differences embodiment might conceivably make' (Pitts-Taylor, 2016, 125). Meaning-making discourses are shaped by complex factors of *brainbody* functioning in the world. These disciplinary types include the *neurological body* 'conceived in relation to the central nervous system, to neurons, neurotransmitters, and brain regions', the *minded body* 'whose psychic capabilities are material and physical as well as phenomenological and situated' and the *social body* 'made not only in evolutionary time but also in the immediate past and present, in relation to other bodies (and things) with which they coexist' (Pitts-Taylor, 2016, 1). This assemblage model plays an important role in understandings of *brainbodies* beyond the frames, mechanisms and apparatuses of neuroscientific image production. The space of artistic research and what it offers as a differentiating mode of enquiry in meaning-making activity is part of this section's consideration of the 'embodied mind' in the contexts of art and curation.

According to the artist Ursula Biemann in 'Geochemistry and Other Planetary Perspectives':

In artistic research, it is often more rewarding to direct only partial attention to the explicit object of analysis and leave ample space to roam the wider field, to encounter and examine the surprising juxtapositions and coincidences that all fieldwork generates. This open methodology favours a state of divided attention, granting the freedom to relax in all directions. In this mode of open research, one is disposed to not merely define the findings, but to create new and unlikely coalescences with semi-conscious affects and ideas, and with other material and immaterial surroundings, which all converge in a shared narrative matrix. (Biemann, 2015, 120)

Research enquiry in and through an 'open methodology' gives space for coalescences between phenomena and image-making. This way of thinking allows material acts to take shape in and through the diffractions and entanglements generated by the literacies of art, curation and neuroscience. As a space of and for interferences, meaning-making is made possible from out of the reconfigurations of difference and the relations they give rise to. Moreover, if plasticity is part of these meaning-making forms of experience, how does it render these forms possible in artistic research?

An exchange (and entanglement) between neuro-aesthetics and theosophy was staged at The 14th Istanbul Biennial *SALTWATER: A Theory of Thought Forms* (5 September – 1 November 2015) under the artistic direction of the curator Carolyn Christov-Bakargiev. In this context, *brainbody* phenomena became productive variances through the semantic pluralities of

plasticity and their convergences with artistic mattering. Through her curatorial practice and as director of *dOCUMENTA (13)* (9 June-16 September 2012) and *SALTWATER*, Christov-Bakargiev has worked to generate conditions for entanglements to become visible, often through staging the partialities of differing disciplinary perspectives.

i. *dOCUMENTA (13)* and *The Brain*

As an exhibition within an exhibition, the Rotunda (a museum space in the Fridericianum in Kassel, Germany) was re-named *The Brain* for the 100-day duration of *dOCUMENTA (13)*. In the literature accompanying the project Christov-Bakargiev describes the space as a 'dense aggregate of things': a core of 'radiating elements, touched and illuminated by works outside' (2012a, 35). As the site of socio-politico-cultural trauma artistic forms gave place to an 'assembly of relations' (Christov-Bakargiev, 2013) crossing space and time. The display of objects in *The Brain* generated an open network of ideas, spaces and situations. This was not an environment modelled by a curatorial concept. Rather, as Christov-Bakargiev explains, *The Brain* is an 'oneiric and programmatic space in lieu of a concept' (2012a, p.35). As a dream-state it housed juxtapositions and re-stagings: an associative space for the 'thought lines' of *dOCUMENTA (13)*. Works on display included material forms embodying social, political and cultural encodings. For example, Vandy Rattana's photographs of 'bomb ponds' taken in Cambodia in 2009 depicted craters embedded into the landscape, the markers of raids carried out in the Vietnam War, between 1964 and 1973. Rattana's documentary journey features archival footage and interviews with villagers who re-tell their experiences of the bombing. The photographs are an imaging process which renders visible a history that had been buried. Some objects in *The Brain* served as place-holders for artistic processes located in other gallery sites across Kassel. Vases used by Giorgio Morandi for his paintings and the selected

editions of Man Ray's *Indestructible Object*, 1923-1965, registered links between objects and artistic processes. The palette knife of Lebanese-American visual artist Etel Adnan acted as a referent to a series of untitled canvases (1959-2010) in the Documenta-Halle. These abstract paintings circulated the walls of a white cube space. A puppet from Wael Shawky's video *Cabaret Crusades* (2010-2012) was also displayed, to be later animated as part of a screening of marionette histories in the Neue Galerie. And a model of Konrad Zuse's Z1 gestured towards the installation of the actual computer housed in the Orangerie. Artistic and archival fragments sat side by side, each serving as reference points for a network of choreographic situations outside and beyond the sealed space of *The Brain*. This constellation, subject to retrieval and forgetting, is like the Long Term Potentiation (LTP) of the plastic brain, where psychic and somatic intensities are reprocessed over time to be carried into reoccurring motifs of meaning in lived experience. In the context of *The Brain* these are 'collapse and recovery, catastrophe and trauma, loss and retrieval, retreat and withdrawal' (Christov-Bakargiev, 2013). For Christov-Bakargiev, the 'oneiric space' of *The Brain* engages our thinking about 'how different forms of knowledge lie at the heart of the active exercise of reimagining the world' (Christov-Bakargiev, 2012a, 31).

A conceptual formation that renders visible the material convergences between things/experiences/fragments in the embodied mind of the *brainbody* is the 'compost'. As Christov-Bakargiev explains in a Leverhulme funded lecture delivered at the University of Leeds in 2014, entitled 'Worlding: From the Archive to the Compost', the space of the compost sets into play different ways of thinking with matter and their transformative entanglements. The intra-activity of ideas and works of art is what makes *DOCUMENTA (13)* a form of 'cultural composting that generates new stories' (Christov-Bakargiev, 2014).

Plasticity and composting are the material entanglements of *dOCUMENTA (13)*: from the structuring of the exhibition itself across many sites, to the choreography of the works of art in an oneiric space, through to the production of diffracted modes of reading in and with the conditions of the event itself. All of these entanglements played a role in the transformative capabilities of plastic matter. As Christov-Bakargiev explains, *dOCUMENTA (13)* is 'dedicated to artistic research and forms of imagination that explore commitment, matter, things, embodiment, and active life in connection with, yet not subordinated to, theory and epistemological enclosures' (Christov-Bakargiev, 2012a, p.31). Therefore, crossing into the worlds of physics, biology, eco-architecture, organic agriculture, renewable energies, philosophy, anthropology, economic and political theory, fiction and poetry, as evidenced in the literature accompanying the post-production materials of *dOCUMENTA (13)*, disclosed the ways in which 'relations intersect with things, moments when matter comes to *matter*' (Christov-Bakargiev, 2012a, p.31). Material residues and remainders formed *com-positing* assemblages. *dOCUMENTA (13)* was a landscape of memories in dialogue with the creative capabilities of plasticity: of its potential to think with, be transformed by, and sit in co-existence with matter.

ii. **SALTWATER and the 'Thought Form'**

By extension, the artistic drive of *SALTWATER* was to consider the 'thought form' in relation to all kinds of waves and oscillating patterns. Organized by the Istanbul Foundation for Culture and Arts (KSV) and under the direction of Christov-Bakargiev, the biennial featured over 80 participants in 36 venues over both sides of the Bosphorus (the European and the Asian). The material inspiration for the exhibition was saltwater and the imagery of knots and waves. This artistic exploration was part of a diffractive process where energies were formed and re-

formed through the prisms of different phenomena. As Christov-Bakargiev explains in an announcement in April 2015 on the biennial website:

A number of drawings, paintings, installations, films, objects, books, collaborations, and research-based events will be viewable as thought forms – waves or oscillating patterns of repeating and differing lines that structure and enfold all forms of transference of energy – from brain waves to shockwaves after an explosion, from sound waves and waves of water to electromagnetic waves of different lengths and frequencies, including radio waves and light. (Christov-Bakargiev, 2015)

My reading of the ‘research-based events’ Christov-Bakargiev mentions above is channelled through the symposium ‘Thought Forms and Brain Waves, Neuro-Aesthetics and Art (30 October 2015)’, initiated by artist Marcos Lutzens as part of the *Speech Acts and Forms of Discourse* public engagement activities for the Istanbul Biennial. This event brought together speakers from the fields of art, art history and neuroscience, to explore disciplinary exchanges between, on the one hand, neuroscientific claims to embodied cognition, including that of mirror neuronal embodied simulation (ES) (as presented in the lecture by the neuroscientist Vittorio Gallese) and, on the other hand, inter-subjective thinking processes at work in Annie Besant’s and Charles Webster Leadbeater’s theosophical accounts of bodily experience (as discussed by the art historian and archivist Pietro Rigolo). Christov-Bakargiev also participated in these exchanges. This disciplinary communication registered different knowledge-making apparatuses as translation tools of and for *brainbodily* activity. In this respect consideration of the *brainbody*’s role in this process is framed by certain pre-assumptions about what constitutes ‘embodied cognition’ and ‘bodily experience’ from within the frames of

neuroscience and theosophy.

Christov-Bakargiev's curatorial project is directly informed by Besant and Leadbeater's book *Thought Forms: A Record of Clairvoyant Investigation*, first published in 1901. Besant's involvement in the Theosophical Society, founded by the Russian émigré, occultist and philosopher Helena Blavatsky in 1875, contributed to the development of several investigations into the so-called pseudo-science of clairvoyant spiritualism. The book draws upon mystical and occultist philosophies and the idea that the matter of the mind enters into the world as auratic projections. It addresses the 'radiating vibrations' and 'floating forms' of mental-psychic-astral thought projections, emanating from and received by *brainbodies*. These projections were rendered visible by artist-illustrators, named in the book as John Varley, Mr. Prince and Miss McFarlane. Besant and Leadbeater worked with them to visually translate emanations through the medium of paint. As a collection of thought-forms, the book's inclusion of Besant's own analysis of coded imagery in and through the painted illustrations gives visibility and meaning to psychic intensities. Waves of emotion generate agitated states of change which enter into the atmosphere to be read by the clairvoyant. These intra-psychic emanations are coded into a colour spectrum. The auratic waves of red, brown, grey, green, carmine, blue, orange, yellow and azure are aligned to feelings of anger, avarice, depression, deceit, jealousy, adaptability, humanity, pride, gratification and self-renunciation. The apparatuses and conventions of artistic processing (painting/illustration) thus generated image-forms from out of the specific literacies of the Theosophical Society. The meaning-making processes involved translations of psychic phenomena into images through the practices of art. As an imaging process we cannot help but be confronted with colour coordinates analogous to the neuroscientific coding of the brain scan.

The speakers at the symposium were engaged in a process of cognitively enacting an entanglement between the brain waves of neuro-aesthetics and the painted illustrations of thought forms. The dynamics of exchange that ensued inevitably exposed some of the tensions of cross-disciplinary articulation and, perhaps, with the subtle undertone of Christov-Bakargiev's curatorial direction, a certain privileging of the partialities of each perspective presented at the event. Two image-making processes were brought together into an environment the dynamic administration of which helped to facilitate the plasticity of thinking with and through semantic literacies and knowledge making practices. Knots *and* waves.

Gallese, renowned for research into the 'mirror neuron' describes in great detail, with empirical evidence in the forms of brain images and codified data, how mirror neurons are part of cognitive neuronal re-processing. The title of his paper "'The 'Problem of Images': Embodied Simulation and Experimental Aesthetics' sought to show how embodied simulation evidences visceromotor and sensory-motor responses to the representations of objects, space and the actions of others within the mind. This neuroscientific evidence was considered in relation to the human mind's experience of images, including art. In this respect, the brain was not only situated as a body intra-acting with phenomena in the world, it was also repositioned by embodied simulation theory. Empathic feeling, suggests Gallese, is generated by the viewer's neuronal ability to mimic and mirror what is being observed. His development of a mirroring system to describe the biological mechanisms at work in the processing of meaning passed through the mechanisms of functional imaging. The speculative conclusions drawn by neuro-aesthetics situated the production and reception of art inside the space of

‘unified experience’. Our sense of connectedness and reciprocity is seemingly generated out of our neurophysiological abilities to empathize on multisensorial levels and through recognition of similarities in experience. In the context of contemporary neuroscience and the discovery of the ‘mirror neuron’, *mimicry* becomes the artistic tool for accessing neuronal behaviours and empathic responses. The reception of the ‘mirror neuron’ in the world of neuro-aesthetics thus extends to the readability of images and what they appear to convey.

Rigolo’s paper ‘A Radiating Vibration and a Floating Form – Thought Forms and Intersubjectivity’ analyzed the writings and illustrations presented in Besant and Leadbeater’s book, with the aim of showing how thinking/thought is a vibrating energy producer and transmitter of emotions (*not* necessarily associated with empathy). In the small catalogue entry of essays and writings for the *SALTWATER* biennial, Rigolo writes:

Art has always involved the representation of thought-forms and in a certain way, it is a thought-form itself. At the same time, thought-forms can be used as a model to think about art: in both of them, indeed, the levels of the real, the imaginary and the symbolic are knotted together, and we are confronted with the ethical problem of what to do with our desires. (Rigolo, 2015, 29)

This consideration of the ‘thought-form’ and the knot of meaning-making generated by artistic processes allows a return to my consideration of *brainbodies* as critical negotiations *with* neuroscientific ways of thinking, as much as constituents *of* them. In this context it is difficult not to feel the weight and pressure of embodied simulation theory bearing itself down onto the ethics of ‘our desires’. For in the neuroscientific space of the brain as a network

of firing ‘mirror neurons’ we are not given space to consider the agential power of the psychic drives and intensities within our *brainbodies*. Instead, desire is re-articulated through the mimicry of emotions and re-framed by empathic recognition. Desire becomes a desire *for* the mirror neuron to serve as the evidence base for the meaning-making processes of mental life. This particular articulation of neuronal activity negates the *brainbody*’s mental articulations of the physiological, psychic and social embodiments – real, imaginary and symbolic – of lived experience. I am arguing, in effect, that contemporary neuroscientific claims to the *brainbody* as a site of and for aesthetic encounters needs the so-called ‘mad science’ of theosophy to help temper its nerve and engage the vibrations of other endings. We are, once again, confronted with the ‘epistemic multiplicity’ of Pitts-Taylor’s assemblage model of the ‘embodied mind’. As mechanisms of and for ‘seeing’, the image producing apparatus of the fMRI scanner and/or the artistic processes of illustration are as much data capturing mechanisms as they are image-makers. The biological bases and scientific justifications for the aesthetic experiences of art are part of the knowledge-making practices of neuroscientific ‘embodied simulation’. However, what is of primary interest in this context is *how* the theosophical ‘thought-forms’ of Besant and Leadbeater *and* ‘embodied simulation’ (of the neuroscientific kind) became entangled within the curatorial space of a public exchange.

Rigolo also evidences the reception of *Thought Forms* in the world of abstract painting. The image-forms of the illustrator-coders (the painters of the astral phenomena) became sources of inspiration for the development of twentieth century abstract art, in particular, the early paintings of Kandinsky, Mondrian and Klee. And yet, art was not the primary concern or interest in the work of Besant and Leadbeater. In fact, their investments in scientific investigation also risk relegating the image-making practices of painting and illustration as

mere tools in a network of theosophic concerns. As Rigolo explains elsewhere in “‘They needed coloured fire, and had only ground earths’”: The Illustrations for Thought Forms’, the processing of spiritualistic phenomena that so preoccupied Besant and Leadbeater was embedded in a scientific context at the turn of the twentieth century, where the imaging of ‘invisible forces’, such as vibration, played a key role in the discovery of new ways of ‘conceiving space, matter, energy, and consciousness itself, with the discovery of phenomena such as X rays [...] radiowaves, atomic structure, radioactivity, and the development of experimental psychology’ (Rigolo, 2017, 64). So, whilst on the surface it might seem that the theosophical pursuits of Besant and Leadbeater were primarily artistic and ‘imaginary’, their investigations were equally preoccupied by the scientific phenomena of the time.

iii. The plasticity of thinking and its interferences

Alongside the emergence and establishment of neuronal scanning apparatuses in the 1980s and 1990s, was a simultaneous development in cognitive science, of approaches to embodied, embedded, enactive and extended ways of acquiring knowledge through perception and mental processing. As Francisco Varela, Evan Thompson and Eleanor Rosch explain in their book *The Embodied Mind: Cognitive Science and Human Experience*, first published in 1991, enactive cognition in particular, plays a role in the formations of sensory-mental experience. For example, the knowledges needed for considering colour as a ‘perceived attribute of things in the world’ (Varela, Thompson, Rosch, 1991, p. 158) is shared and shaped by a range of disciplinary practices including neuroscience, AI, linguistics and philosophy. The role of ‘embodied action’ in an understanding of the sensori-motor processes at work inside the biological, psychological and cultural contexts of cognitive experience, brings ‘enaction’ to the fore as a dynamic interaction (or intra-action) of mind situated in an

environment. In the context of the mirror neuron the very introjection needed for the mind's synaptic firing is an astral projection into another space; a space beyond the limits of the scanning apparatus. Perhaps the mirror neuron and astral seeing are of the same genetic tool make-up.

The philosopher, Alva Noë, in his book *Strange Tools: Art and Human Nature*, re-situates the premise of artistic research and its modes of seeing in the context of the 'neuroscientific turn' and its specific knowledge claims. He rightly explains, taking on board the wealth of philosophical thinking about aesthetic experience in the eighteenth century (Kant in particular), that aesthetic responses are reactions to phenomena which trigger necessary 'enactions' with art. Noë writes:

Neuroscience [...] treats art as a phenomenon and so studies art the way it studies any phenomenon. Art objects are triggers distinguished by the distinctively "aesthetic" character of the experiences to which they give rise. [...] Art isn't a phenomenon to be explained. It is, rather, a mode or activity of trying to explain. (Noë, 2015, 133)

It is this mode of 'trying to explain' that aptly articulates the efforts of this article and its 'desire' to work with partial perspectives, embodied, situated and embedded within the practices and processes of image making and their resultant forms. As an agential mode of enquiry at work in different contexts, plasticity gives place to waves of encounter with other thought forms in the world as part of the entanglements of matter and meaning. This includes a dispersal of the readable codes of visual systems. My own diffractive reading has considered how image-form productions emanate from out of a force field of entangled energies and

intensities. The plasticity of thinking is the thought-form. It is an intra-active agency, an entanglement in different phenomena, a mattering that matters. Plasticity is at work when the discourses of the scientist and the seer, the technologist and the clairvoyant, pass through each other. Plasticity makes creative acts of formation possible.

The many image-forms of plasticity, as they appear in the discourses of neuroscience, art, psychoanalysis, philosophy, and even, management studies, makes it possible to register the multiple and diverse translations of materiality, and as Barad (2007; 2010) suggests, to engage with matter as the ongoing differentiation of the world. She explains: 'Matter is not immutable or passive. Nor is it a fixed support, location, referent, or source of sustainability for discourse' (Barad, 2003, 151). Rather it is in the processes of materialization that a dynamic materiality is produced in practice. Materially-discursive practices are part of the mutual articulations of matter and meaning. Some materializations make a difference as performative constituents in the world. This is evidenced by Malabou through her many readings of the powers of plasticity, including those articulations that stem from neuroscience (see for example, Crockett and Malabou, 2010, Malabou, 2007; 2009; 2010; 2012a; 2012b). Mattering is thus a continuous processing of the physical relations between existing and emergent forms in the world, which includes the ways in which image-forms are materially produced, received and transformed.

In the context of the symposium 'Thought Forms and Brain Waves, Neuro-Aesthetics and Art' my diffractive reading of *brainbody* phenomena through the disciplinary mechanisms of neuroscience and theosophy allowed the distorted flows generated by a colour spectrum to be derived from *both* scientific and psychic registrations. The intra-bodily exchanges between

psychic forms and their projections into the world re-situates neuroscientific claims to the mirror neuron and the activities of the embodied mind. This is what *brainbodies* produce and receive from each other as plastic acts of thinking. As Haraway explains, 'diffraction is a mapping of *interference*, not of replication, reflection, or reproduction. A diffraction pattern does not map where differences appear, but rather map where the effects of difference appear' (Haraway, 1992, 300). Inherent within this entanglement is a thinking process which engages *brainbody* phenomena in, with and through an assemblage model of embodied and situated life forms (molecular, psychic and material), including the disciplinary terrains we might need to call upon to explore the differentials of materially lived experience.

Summary and conclusion

As an operative and performative concept, plasticity travels and inhabits different disciplinary fields, and in doing so, has been integral to the enactments and cultural entanglements at work within this article. Plasticity enters into disciplinary domains to generate new networks of meaning. As a cognitive agency within the *brainbody*, plasticity enacts, through its many dimensions, differential multiplicity. On the one hand, the image-forms presented within this article show a binding to the apparatuses that have materialized them. On the other hand, they are also convergences for generative meaning to be 'made-together-with'. In a conversation with feminist science studies scholar and biological storyteller, Martha Kenney, Haraway describes this 'thinking-with' as a 'response-ability', both 'irreducibly collective and to-be-made. In some really deep ways, that which is not yet, but yet may be. It is a kind of luring, desiring, making-with' (Haraway, 2015, 257). In this sense, *brainbody* plasticity is always already more than an objective description of what the brain is as a dataset. It is also situated by and bound up with dimensions that move beyond the neuroscientific model: the

aesthetic dimension where the malleability of plasticity lends itself to the creative capacities and capabilities of form generation and form annihilation, the ethical dimension where neurological rewiring emanates out into culture to be understood through social and collectively shared insights, and finally, to the political dimension of plasticity, where responsibility is part of the process of ‘the double movement of the receiving and giving of form’ (Malabou, 2008, 30).

The first image-form engaged with the apparatus and workings of Positron Emission Tomography (PET), in particular, how a brain image is constructed from the technical and scientific processes involved. This reading engaged with Dumit’s ethnographic research. Dumit considers PET scanning, not only as a neuroimaging technology that creates visual images of brain and body, but also registers *how* these image-productions are constructed from within the confines of the laboratory environment. The various knots and entanglements of knowledge-making practices that feed into and out of this scientific imagery also includes a space for the different form-dimensions of plasticity. This was revealed through a re-reading of the phenomena of the *brainbody* through PET scanning as an image-production process. Here, material form-annihilation was considered as a specific *brainbody* reaction to the apparatus and was speculatively staged as a critical negotiation with the imaging process as much as constituent of it. Thinking through the collaboration between *brainbody* and technical apparatus as an act of dynamic adaptation allowed for a consideration of the ‘subterranean representational activity’ at work in this process; a disposition towards the making of meaning. The *brainbody*’s reaction to the scanning process as a molecular agency is analogous to Malabou’s articulation of the plasticity of the brain as both ‘creator and receiver of form but also an agency of disobedience to every constituted

form, a refusal to submit to a model' (Malabou, 2008, 6). This provided opportunity to consider how a diffractive reading seeks out for entanglements between multiple dimensions to plasticity. In the PET scanner the *brainbody's* organic system as an 'agential convergence' of conscious and unconscious processes blurs the boundaries between neuronal and mental states.

By extension, the second image-form cultivated a space for cross-disciplinary exchange where the imaging practices of neuroscience and theosophy generated entanglements about the *brainbody* as a producer and receiver of art. Finding ways to read behind, below and beyond the formal conventions and practices of neuroscientific culture (including the neo-liberal repurposing of plasticity into the ideological dictates of flexibility) acknowledges differentiated and differentiating spaces for the multiple form-dimensions of plasticity. I used this context to read neuro-aesthetic knowledge claims in and through the psychic forms of theosophy, thus generating a space where certain mechanisms and conventions of seeing were read through each other. In this respect, the curatorial spaces staged by Christov-Bakargiev's projects *dOCUMENTA (13)* and *SALTWATER* created opportunities for acts of boundary shifting to occur. This allowed our cognitive capabilities to be alerted to the demands of the *brainbody* as a creative agent of plasticity.

Reading and writing through the neuroscientific *brainbody* (with Dumit) and the artistic *brainbody* (with Christov-Bakargiev), in the embedded and situated sites of their image-form making processes, was a purposeful strategy to move beyond the limitations and conventions of disciplinary reading practices. By embracing diffraction as a strategy which reads insights through each other (Barad), image-forms can serve as the carrier of new imaginaries in the

intertwining worlds of neuroscience, art and curation. In this sense, the artistic processing of technoscientific phenomena is an aesthetic, ethical and political ‘thinking-with’, a shift from the epistemologically known towards open methodologies which engage the differentiating formations of our cognitive capabilities. This is part of Malabou’s call for us to consider what we should do with our brains and its multiple plastic dimensions.

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