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Proposal for a Critical Neuroscience

Jan Slaby and Suparna Choudhury

The label "critical neuroscience" captures an important—and, we believe, productive—tension. This tension represents the need to respond to the impressive and at times troublesome surge of the neurosciences, without either celebrating it uncritically or condemning it wholesale. "Critical" alludes, on the one hand, to the notion of "crisis," understood—in the classical Greek, predominantly medical sense of the term—as an important juncture and point of intervention, and, relatedly, to a task similar to that proposed by Kant (1992) in *The Conflict of the Faculties* (rather than in his more famous "Critiques"), where he defends a space of unconstrained inquiry into the continual pressures put on scientific knowing by the vagaries of the political sphere. This opens up a space for inquiry that is itself inherently and self-consciously political. On the other hand, the concept of "critique" raises important associations with Frankfurt School critical theory. While critical neuroscience does not directly follow a Frankfurt School program, nor the reduction of science to positivism espoused by early critical theory, it does share with it a spirit of historico-political mission; that is, the persuasion that scientific inquiry into human reality tends to mobilize specific values and often works in the service of interests that can easily shape construals of nature or naturalness. These notions of nature or of what counts as natural, whether referring to constructs of gender, mental disorder, or normal brain development, require unpacking. Without critical reflection, they appear as inevitable givens, universal and below history, and are often seen as a form of "normative facticity," making specific claims upon us in everyday life (see Hartmann, this volume).

In this chapter, we will spell out how our proposal for a critical neuroscience is not motivated by the aim to undermine the epistemological validity of neuroscience or debunk its motives, nor is it simply an opportunity to establish yet another neuro-prefixed discipline. Situated between neuroscience and the human sciences, our notion of critical neuroscience uses a historical sensibility to analyze the claim that we

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are in the throes of a "neurorevolution" since the beginning of the Decade of the Brain in 1990. It investigates sociologically the motivations and the implications of the turn to the *neuro* in disciplines and practices ranging from psychiatry and anthropology to educational policy, and it examines ethnographically the operationalization of various categories in the laboratory. Investigating the historical and cultural contingencies of these neuroscientific categories, critical neuroscience analyzes the ways in which, and conditions through which, behaviors and categories of people are naturalized. It also traces how these "brain facts" are appropriated in various domains in society, starting with medicalized contexts of the West, but also using cross-national comparative methodology to understand the production and circulation of neuroscientific knowledge globally. Maintaining close engagement with neuroscience is, on the one hand, crucial for building accurately informed analyses of the societal implications of neuroscience, whilst, on the other hand, providing a connection, a reflexive interface, through which historical, anthropological, philosophical, and sociological analysis can feed back and provide creative potential for experimental research in the laboratory.

In attempting to build up a picture of what critique might look like for this project, we avail ourselves of a number of disciplines and sensibilities that can contribute as resources for critique. Our goal is to render critique amenable to a number of diverse disciplines—we propose that this versatile set of tools can contribute to reviving a critical spirit while also broadening the neuroscientist's gaze. That being said, we certainly do not intend to outline a fully-fledged, scholarly program or recipe for critique. Instead, we will try to sketch some building blocks for a mode of engagement, an ethos, that aims to raise awareness of the factors that come together to stabilize scientific worldviews that create the impression of their inevitability. Furthermore, critical engagement in neuroscience can increase the complexity of behavioral phenomena (for example, emotions, interaction, decision making, mental disorders), and motivate scholars to enrich conceptual vocabularies of behavior and mental illness, keeping debates from being foreclosed by the belief that the ontologically most fundamental level of explanation is by default the most appropriate one (see Mitchell, 2009).[1]

To bear relevance outside the narrow scholarly sphere, such an endeavor requires a self-reflexive hermeneutics that is necessarily multi-dimensional (or "undisciplined"). The result, we envisage, will not so much be an unpacking of the black boxes of the neurosciences as an assemblage of resources that ultimately widens the ontological landscape of a behavioral phenomenon under study. It is the plurality—reflecting the complexity of behavior as well as the many contingencies of neuroscience—of elements of this landscape that gives rise to the solidity of a claim, the "realness" of a fact. Contextualizing neuroscientific objects of inquiry—whether the "neural basis" of addiction, depression, sociality, lying, or adolescent behaviors—can, in this way,

[1] Recent debates about levels of explanation, reduction, and complexity in the philosophy of science demonstrate that the field is increasingly departing from the classical hierarchical models in which a fundamental physical level is deemed the only truly explanatory level, such that all higher levels of a complex system's organization have to be reduced to it. Sandra Mitchell's complexity theory-inspired argument for "integrative pluralism" is a helpful case in point (Mitchell, 2009). See also the useful charting of relevant debates in Brigandt & Love (2008).

demonstrate how such findings, whilst capturing an aspect of behavior in the world, are also held in place by a number of factors, co-produced by a collection of circumstances, social interests, and institutions (Hacking, 1999; Young, 1995). These circumstances and interests are often quite systematically ignored in neurodiscourse (see, for example, Heinemann & Heinemann, 2010).

However, we propose that critical neuroscience should not stop at description and complexification. Indeed, we share a sense of uneasiness, recently voiced within the field of Science and Technology Studies (STS) in particular (Anderson, 2009; Cooter, 2007; Cooter & Stein, 2010; Forman, 2010) about depoliticalization of scholarship in the face of the increasing commercialization of academia. In line with a broader cultural tendency favoring voluntarist conceptions of the "entrepreneurial self," centered around ideas of "resources" and personal "capital" (social, emotional, "mental"), we sense an implicit correspondence between scholarly discourse and economic imperatives and normative schemas.[2] Certainly, these are preliminary intuitions, and we will not impose ready-made answers. However, we share the conviction that a more radical and openly political positioning is needed in face of these trends. In the first instance, it is important to reinvigorate a sense of the impact that larger social, political, and economic dynamics have on the very shape of academic and scientific culture. We return to this below.

Assemblage: The Thickening of Brain-Based Phenomena

Bruno Latour, in his animated essay about critique and its effect of *weakening* scientific facts, appeals to his critically-oriented readers to "suspend the blow of the [critical] hammer" and calls for a renewal of a realist attitude oriented to matters of concern, rather than matters of fact (Latour, 2004). Matters of concern are those around which the human world revolves: they enthrall us, involve us, and challenge us to embrace or oppose them—they will be the focal point in practices, discourses, disputes. Critical neuroscience shares this constructive spirit, the "stubbornly realist attitude" and the focus on what matters in relation to scientific practices (Rouse, 2002). Importantly, critical neuroscience embraces the added dimension that enters the scene with the focus on matters of concern: values, conflicting moral outlooks and evaluative perspectives, changes in the attribution of relevance pertaining to a given phenomenon or scientific result, often contested among affected parties. Critical neuroscience thus emphasizes the politics implicit in scientific practices (see Rouse, 1987, 1996).

However, while Latour is helpfully non-dogmatic and quasi-democratic in giving a voice to participants in practices—both human and non-human—in the process of assembling their collectives (instead of silencing the actors behind grand-scale theoretical assumptions), in the end, he relinquishes too much—by sidelining entirely any non-local invocation of the social, the economic, or the political. By contrast, our proposal for critical neuroscience calls for a less detached attitude on the part of the critical investigator, a more active engagement, and, at times, a more confrontational

[2] How these postmodernist tendencies might have rendered explanations that invoke "social influences" less common and less valued in STS is helpfully discussed by Forman (2010).

response in cases of violation of scientific standards (Fine, 2010), strategies of ignorance (McGoey, 2009), imperialistic export of Western assumptions to Non-Western contexts (Watters, 2010), or the political use of preliminary data (Choudhury, Gold, & Kirmayer, 2010; Raz, this volume). Such responses need to be supported by attempts to identify and render explicit more subtle biases and frames of evaluation: the specific organization of public attention, patterns of distribution of affective energies, collectively sustained valuations and schemes of judgment that are instituted in subtle but pervasive ways in both scientific and popular discourses, in representations of scientific results, but also in spheres of public understanding at some distance from the practice of research. Notions such as the neural basis of adolescent risk taking, hard-wired sex differences, molecularized understandings of mental illnesses, or narratives about behavioral and emotive tendencies universally present in humans and set in stone by evolution are cases in point. Some of these narrative patterns solidify to form what Judith Butler has called "frames"—powerful but often unnoticed ways in which perception, knowledge, and normative judgment are preorganized so that some conceptualizations and evaluations are made likely while others are ruled out a priori (Butler, 2009). Critique here has the task of working against engrained habits of perception, thought, and judgment in order to enable alternative framings of matters of concern.

What we envisage as the practice of critique, therefore, starts with the activity of assembling (Latour, 2004, p. 246; Slaby, 2010). "Assembling" refers to the collection of material from multiple sources and perspectives to enrich scientific conceptualization as well as the broader intellectual horizon in which problems and issues are framed for empirical investigation and interpretation. Objects of neuroscientific investigation can, as a result, be situated in the full fabric of meaningful relations—while this very fabric is itself placed under scrutiny and has to be kept open for contestation. The social situatedness, cultural meanings, and various interests of affected groups all package the ontological landscape of neurocognitive phenomena. This view holds that what we see in the brain is at any time held in place by a rich web of factors within the epistemic culture (Knorr-Cetina, 1999; Young, 1995), and in the ambient society, which in turn mobilizes these findings beyond the laboratory. Insights from multiple disciplines can bring to light the internalized scientific ideals, or "epistemic virtues" (Daston & Galison, 2007) that direct the formulation of neuroscientific findings—the filtering of information, the criteria for, and goal of, objectivity, and the operationalization of chosen aspects of the lifeworld (Cooter, 2010).

To illustrate this, let us take the example of addiction. Addiction is increasingly understood as a disease of the brain, in which addictive substances cause malfunction of the frontal regulation of the limbic system, thus "hijack[ing] the brain's reward system" (Leshner, 2001) and potentially even altering gene expression (Kuhar, 2010). The goal of these brain-centered approaches to addiction is to locate candidate molecular mechanisms that can lead to effective new treatments (Hyman & Malenka, 2001). While these studies have yielded some notable findings, addiction is far more than (and different from) a mere change in brain chemistry. "Addiction" denotes a family of conditions that are inextricably tied up with social environments, drug markets, and cultural triggers (Campbell, 2010), and depend on collectively developed and sustained habits (Garner & Hardcastle, 2004) and also upon institutional

practices that emerge in response, as a feedback, to the original phenomenon—through classificatory looping as described by Ian Hacking (Hacking, 1995, 1999, 2007; see also Raikhel, this volume).

Approaching addiction using an ecological systems view, through multiple epistemic cultures, would mean to re-inscribe and integrate these multiple causal factors. Such an approach would examine the linkages across levels of description using various methodologies and would include recording the cultural phenomenology of addictive behaviors. It would additionally attend to the political economy of addiction and the effects of industry on concepts of addiction (Rasmussen, 2010). Taken together, this integrative approach will yield an explanandum much richer than any of the single construals developed exclusively from a single scientific or medical perspective.[3] Clearly both registers—social and biological—are necessary to assemble a richer understanding of addiction. The more relevant questions for a critical neuroscience to work out will be how to overcome the gap between social and neural, how to develop conceptual vocabularies and frameworks that overcome this stark distinction, and how to empirically study phenomena like addiction with a view of the *situated* brain and nervous system. This goal would take as a premise that the brain and nervous system are nested in the body and environment from the outset and that their functions can only be understood in terms of the social and cultural environment (Choudhury & Gold, in press).[4]

How Does the Social Get Under the Skin?

Ethnographic work by Margaret Lock has provided powerful evidence for the need to collapse conventional dichotomies between the "inside" and "outside" of the human body. Her seminal study of the experience and physiological characteristics of menopause among Japanese and American women led her to the concept of "local biologies," a useful way to denote her finding that social context and culture can refashion human biology (Lock, 1993; Lock & Kaufert, 2001; Lock & Nguyen, 2010, ch. 4). Lock found that the cultural differences in menopause/*konenki* ran deep, manifesting on biological, psychological, and social levels. She argued that the different experiences of hot flushes were not simply due to differences in cultural expectations in relation to the body, but down to the biological effects of culturally determined behaviors such as diet. This finding challenges the tendency in biological science to draw boundaries at the skin, and demonstrates instead the ongoing dialectic between biology and culture. Laurence Kirmayer has extended these ideas to the brain and behavior through his concept of "cultural biology," which understands

[3] Phenomenological analysis can play an important role in these enriching constructions of behavioral phenomena—in the case of addiction and certainly with regard to many other objects of neuroscientific inquiry. See, for example, Gallagher (this volume), Ratcliffe (2008, 2009), and Zahavi (2004). On the other hand, it would be wrong to assume that phenomenological approaches alone could be the answer in amending the limitations and reductive tendencies of empirical investigation. Phenomenological construals themselves have to be reflexively questioned and balanced with social contestations to prevent the erection of the myth of a universal, ahistorical, and authoritative sphere of pure experience.

[4] For the more general background to this perspective, see Noë (2009), Protevi (2009), and Wexler (2006).

culture as a biological category in the sense that human beings have evolved a "biological preparedness to acquire culture … through various forms of learning and … neural machinery" (Kirmayer, 2006, p. 130). Lock and Kirmayer's concepts of local biologies and cultural biologies, respectively, capture a notion of central importance to critical neuroscience: biology and culture are mutually constraining and co-constitutive, such that they are each conditions of the other's determination and development.

Explanations that situate brain and cognitive function within the social and cultural environment of the person are, in fact, increasingly encouraged within psychiatry and neuroscience. Calls for interdisciplinary research that lead to integrative explanations are certainly heard within psychiatry as a route to developing multi-level theories of disease and their etiologies (Kendler, 2008). Advances in epigenetics have been especially influential in fueling major shifts in scientific thinking about the linkages between the body and its environment, between soma and society (Pickersgill, 2009). Research on epigenetics has begun to reveal how interactions between the genome and the environment over the course of development lead to structural changes in the methylation patterns of DNA that regulate cellular function. There is compelling evidence, for example, that early parenting experiences and social adversity alter the regulation of stress response systems for the life of the organism (Fish et al., 2004; McGowan et al., 2009; Meaney & Szyf, 2005; Weaver et al., 2004). Such studies provide biological evidence that lived experience, developmental histories, dynamic interactions, and cultural contexts are all fundamentally bound up with biological processes as "low level" as gene expression.

In parallel to these developments in genomics, social and cultural neuroscience have become the most rapidly-developing areas of cognitive neuroscience. While social neuroscience explores linkages between social interaction processes and the brain, cultural neuroscience investigates cultural variation in a range of psychological processes with respect to brain function. These research fields posit that the human brain is fundamentally a social brain, adapted for social learning, interaction, and the transmission of culture (Emery, Clayton, & Frith, 2010; Frith & Frith, 2010; Rizzolatti & Craighero, 2004). Moreover, its structural malleability is understood to be experience-dependent and long-lasting. Evidence of genomic and neural plasticity thus forces scientists to rethink the primacy given to biophysical levels of explanations, and challenges us to destabilize the dichotomy of nature/culture and instead address the fundamental interaction of mind, body, and society.

This concept of the situated brain brings up a number of possibilities and challenges for critical neuroscience. First of all, it requires the critic (or critics in collaboration) to act as a *bricoleur*, collecting data at a number of different levels, layering phenomena, such as menopause or addiction, with these different strands of inquiry that ultimately serve to enrich one another in their explanatory value. Secondly, the emerging discourses of "interaction" require critical analysis by sociologists and anthropologists of science. How exactly are aspects of social life, culture, and individual difference incorporated into scientific observations and methodologies? Furthermore, when the environment and biology are each assigned roles in the development of pathologies, such as schizophrenia or antisocial behavior, how are the social and cultural realms made relevant or visible in medical explanations? How might the more complex

ontologies of mental disorders that result from these integrative explanations bring about new ethical and political challenges by opening up new spaces of intervention or creating new "at risk" populations (Pickersgill, 2009; Rose, 2010; Singh & Rose, 2009)?

Situating the brain and behavior in social and cultural contexts also underscores the importance of examining recursive loops between neurobiological and social/cultural processes such as the way in which explanatory theories of illness and behavior themselves interact with the physiological processes involved. This biolooping, as discussed in the introduction to this volume, refers to the ways that both culture and local biologies can transform one another, exerting their influence on the way we understand ourselves, the way we experience mental and bodily phenomena, and the way that this in turn shapes the corresponding biological processes. We return to these issues later in a discussion of what critical neuroscience can do for neuroscience itself.

Critical neuroscience research is thus understood as a broad, interpretative, and qualitative mode of inquiry. One important—though surely not the only—way to "operationalize" critique lies in the attempt to enrich the often necessarily limited, lab-based empirical perspective by providing science with themes of significance captured within a fabric of meaningful relations in cultural and social settings. The practice of critical neuroscience could in this way serve as a natural complement to the selective attitude and methodological reductionism of experimental approaches.

Re-invoking the Social in Studies of Neuroscience

Openly politicized forms of critique are no longer much in evidence, and may not currently seem very workable (Cooter, 2007; Latour, 2004). Prevalent, for example, in science studies and cultural studies are approaches that appear to trade in critical engagement for an aestheticization of scientific practices, stopping short of penetrating into manifestly pathological developments. One reason for this may be the increasing professionalization and differentiation of various metascientific approaches over the past 40 or so years. Are practitioners no longer "allowed" to operate on a broader, holistic level of social understanding that transcends clearly circumscribed local expertise?[5] It is likely that certain intellectual as well as political and economic developments support some of this academic quietism (Forman, 2010).

In opposition to these tendencies, critical neuroscience strives to regain room for scrutiny, in reckoning with perspective-bound and interest-specific constraints that belie, in some contexts at least, objectivist aspirations of neuroscience and of those enthusiastic about its applicability in everyday life. Certainly, the gathering of context in many cases may end up laying bare the economic and political imperatives that sustain particular styles of thought from "screening and intervening" to "essential

[5] This might be one reason why critique of scientific and medical malpractice and corporate influence has recently been more a business of journalists, popular writers, and non-academic intellectuals than of professional STS practitioners (recent examples: Fine, 2010; Greenberg, 2010; Watters, 2010).

differences" (Abi-Rached & Rose, 2010; Fine, 2010). It may also end up shedding light on the ways in which the very concepts and categories that produce new kinds of responsibility towards the "natural" make-up of our minds are—knowingly or unknowingly—themselves shot through with our projections, and give rise to "facts," worldviews and policies that may collude with social and political orders (Hartmann, this volume; Malabou, 2008). This is well illustrated by Cordelia Fine's recent book, *Delusions of Gender*. Fine, trained both as a cognitive neuroscientist and a science journalist, rigorously analyzes neuroscience experiments, their results, and their interpretations among media exegetes, that purport to show hard-wired differences in behavior between men and women. She demonstrates how biases creep into the assumptions involved in experimental paradigms, and how cultural stereotypes are reified by "brain facts," placing these trends in the context of the social conditions that maintain this prejudice in the form of a new neurosexism (Fine, 2010).

As variously indicated above, critical neuroscience puts particular emphasis on the social. Of course, it is important not to take "the social" as a static, homogenous thing, but rather to work with this notion as a proxy for the associations between scientists, laboratories, media, agencies, governments, and other constituencies. Non-modern approaches such as actor-network theory are in this context very helpful. They do not construe "the social" as the kind of stuff out of which phenomena are literally *made,* and equally steer clear of the opposite extreme of a scientistic naturalization of the social (Latour, 2005, pp. 87–120; see also Latour, 1993). Instead, phenomena, as matters of concern, are reconstructed by being placed in networks of actors and actants forming theme-related alliances and vastly distributed webs of relations. Scientific knowledge as such can be viewed as embodied in material alliances or what Rouse, alluding to Wartenburg's conception of socially distributed power, has called "epistemic alignments" (Rouse, 1996; Wartenburg, 1990). In an important sense knowledge only "exists" in the material–practical interactions between people, things, instruments, agencies, and policies; and thus cannot be understood in abstraction from "the various kinds of resistance posed by anomalies, inconsistencies, disagreements and inadequacies of skill, technique, and resources" (Rouse, 1996, p. 194).[6]

While no grand-scale invocations of "social factors" can substitute for precise analyses of particular interactions and alignments between social actors and material actants, it is important, we believe, to keep the bigger picture in view. It is here that we diverge from the localism of actor-network theory and the STS mainstream: epistemic and political alliances, as well as cognitive and affective frames and interpretive

[6] It is helpful to emphasize again that material objects are themselves integral ingredients in both social power relations and in those material—practical alignments that constitute scientific knowledge: "Things can break down, are unavailable when needed, convey confusing signals, and sometimes even get in the way. Things can also open new possibilities for resistance to the power relations they mediate. And when things do fall out of alignment in these ways, the effects on power relationships are quite comparable to those which follow the breakdown of social alignments. We avoid fetishism not by strictly separating the natural and the social or by reducing the natural to the social but by recognizing the artificiality of the distinction." (Rouse, 1996, p. 190–191). It is hard to not think here of the heavy and complicated machinery that the neuroscience inevitably have to mobilize in order to establish epistemic contact with their object of inquiry (see Dumit, 2004 and this volume).

schemes instituted by them, often operative through media representations or discursive practices that begin in local settings and are subsequently broadened, all contribute to a structure of secondary objectivity or second nature. These processes of solidification can easily escape the purview of science and its commentators because of the incremental nature and slow timescales of change, and because of the authoritative nature of the finished product: established, official, institutional knowledge. The "social" needs to be viewed not as an assumed explanatory factor but as the result of various micro- and meso-level operations and alignments between a wealth of actors, tools, quasi-objects, and agencies. In turn, the social re-emerges as a potential explanatory resource; for example in the mobilization and distribution of attention, of concern and relevance, and in the workings of tacit schemes of interpretation and normative judgment (Butler, 2009). In light of this it is not enough to merely point to ontological hybridization or celebrate one's having superseded modernist dualisms (Latour, 1993, 2005). Neither does it suffice, for our purpose, to neutrally chart the cartography of "emergent forms of life"—such as biological citizenship and neurochemical selfhood—nor simply to leave it upon others to "judge" these developments (Rose, 2007, p. 259).[7]

While such descriptive endeavors provide important staging for subsequent analysis, it is crucial to penetrate beneath the surface of emerging practices, relations, and styles into the dynamics of power that may shape or stabilize surface phenomena, facilitate or hinder certain alliances or actions. It is important to reckon with pathological developments, render explicit interest-driven biases, hegemonic schemes of judging, templates of knowing and classifying, dangerous blind-spots in interpretations, unquestioned narrative patterns, and various unholy material alliances.[8] For example, the neoliberal mobilization of "human resources" in the name of employability, flexibility, and soft skills has found a new space to take shape among neuroscientists performing the naturalization of social/economic categories, and increasingly biologized notions of personhood, human experience, and the good life. Subjectivity is parsed from the outset into economic categories and becomes a type of bio-economic capital that is in turn used to sort people into

[7] We refer here to the puzzlingly moderate final remarks in Nikolas Rose's *The Politics of Life Itself*. Rose's proclamation of neutrality at the end of that work is surprising in face of the many blatantly critique-worthy developments he had charted so rigorously throughout the book. As Cooter and Stein put it, "It is a vagueness that is popular in today's academic world run as it is by the changing fashions and fortunes of grant-giving bodies, for it permits study of almost everything but commitment to nothing—hence, a valuable strategy for the retention of patronage. This is not to say that Rose is openly opportunistic, but he does seem to suggest that one can separate the empirical analysis of contemporary life from larger questions of collective human direction and purpose. He keeps his hands clean" (Cooter & Stein, 2010, p. 115).

[8] Here critical neuroscience preserves what could be called historical solidarity with the project of critical theory: the similarity lies in the attempt to move beyond sporadic interventions towards a theoretically integrated account of a system of normative assumptions, interpretive patterns, and material conditions that jointly stabilize, on the scale of society or significant parts of it, a tacitly pathological status quo. The term "theory" in critical theory is no accident (Geuss, 1981; Honneth, 2009). Almost needless to say, we are currently far from advocating anything in the direction of a worked-out theoretical account of this kind. There is as of yet no critical theory of the neurosciences (on this, see also Hartmann, this volume).

kinds, construct risk profiles, and suggest enrolment in enhancement programs (Fricke & Choudhury, 2011).[9]

Needless to say, within this discourse characteristic of neoliberal think tanks, social experience is thoroughly individualized and cultural and behavioral phenomena are declared "natural" (Brinkmann, 2008). Is this something that we, as academic observers and affected individuals, should merely register in a neutral way?[10] In light of this, we argue that critical neuroscience must ask hard questions about conceptual and normative assumptions and strategic alliances, and work towards re-opening contestations and restaging alternative interpretations and evaluations.[11]

Structural Pathologies in Science and Society

The activity of assemblage, in our sense of the term, is thus an inherently political one. It allows the critic to identify something close to what Axel Honneth has called "social pathologies of reason" (Honneth, 2009, ch. 2):[12] such pathologies are defects or malfunctions in social systems, practices, and institutions—malfunctions that come into view against the background of some normative understanding of society and properly functioning institutions. In the case example of addiction, described earlier, one might come to reckon with diverging perspectives from medical professionals, pharmaceutical companies, health administrators, social workers, governments and political parties, the education sector, newly constituted "risk populations," and certainly "the addicts" themselves. However, "addict"—and similarly, other kind terms in use in neuroscientific research—must be seen as a category that is co-produced through dominant classifications, styles of thought, and cultural practices. Incisive analysis of the interactions which make possible these neurological categories give ground for active assertions about what is at stake in the case of "brain overclaim" or tangible corporate influences on scientific practice.

For example, as Laurence Kirmayer and Ian Gold (this volume) argue, there is a trend in mainstream Western psychiatry to employ increasingly narrow construals of mental suffering that neglect the situatedness of patients in distorted social environments and direct the focus away from cultural embeddedness towards assumed

[9] Take for example the UK Foresight Project's definition of "well-being:" "Mental well-being, […], is a dynamic state that refers to an individual's ability to develop their potential, work productively and creatively, build strong and positive relationships with others and contribute to their community" (Beddington et al., 2008, p.1057; see also Foresight Report, 2008). A related, large-scale government sponsored project is currently being conducted in France, employing a strikingly similar rhetoric (see Oullier & Sauneron, 2010).

[10] What the word "we" refers to here is of course a non-trivial issue. Provisionally, what we mean is the broad group of potential "recipients" of the conceptual transformations alluded to here—in other words those affected by structural changes in the conceptions of subjectivity and well-being brought forth by the current alliance between some practitioners in the human sciences and the spin doctors of corporate culture. To clarify further the exact standpoint of critique is of course important—but on the other hand not as important as to be able to postpone the beginning of critical reflection indefinitely.

[11] The important theme of norms is taken up again below.

[12] We take up Honneth's notion in a rather loose manner, divorcing it from the specific context of a theory of rationality implicit in approaches to "critique" from a Frankfurt School perspective.

"neurological underpinnings" of illness, agency, and personhood. Ignoring the social and cultural contexts of phenomena under investigation can render neuroscientific research (unknowingly) complicit with problematic developments in the medical sector, despite the best intentions of individual practitioners. Scientists are not usually trained to be very sensitive to the subtleties of, and social conflicts within, political and institutional environments—as science prizes epistemic virtues of other kinds (Daston & Galison, 2007). This can lead to distorted interpretations of experimental results—with very real consequences in the lives and treatment choices of patients, for example. Continuing the above example of addiction research, a narrowly neuroscientific understanding of substance addiction might lead to the neglect of the conditions that stabilize addictive behavior, and thus encourage forms of practice and treatment less conducive to the well-being of those affected than those that become available through a more complex understanding of the condition. Moreover, such narrow explanations fail to acknowledge the role of politics in addiction and other forms of human suffering.

Likewise, the widespread fascination with brain-based approaches in parts of the wider public calls for more critical responses, since circulation of simplistic accounts systematically serves to obscure these wider and often inconvenient entanglements (Heinemann & Heinemann, 2010; Weisberg, Keil, Goodstein, Rawson, & Gray, 2008). Intensified media representation coupled with audiences increasingly trained, through continuous exposure, to be receptive to easy-to-digest narratives of self-objectification ("your brain made you do it") contribute to the distorted images of the person—as lacking in free will, possessing skewed decision-making powers, being driven instead by automatized emotions, and thus as not genuinely responsible for their acts (while simultaneously making them responsible for "managing" their brains). Pervasive media messages in this manner lead to a climate of opinion that singles out sensationalistic themes, often ideologically laden, and pushes towards simplified, technocratic solutions to social problems (Greenberg, 2010). Critical neuroscience aims to function as an informed voice opposing those distorted images. Importantly, Fine's critique of neurosexism mentioned earlier is made particularly strong by her close engagement with the experimental design and statistics as well as her skill to write compellingly for a broader audience. Given that the flawed findings she critiques have traveled into the popular cultural script of male/female differences, critical writing for a public audience is a vital move that can benefit the repertoire of critical neuroscience activities.

Whose Norms? Expertise, Participation, and Contestation

The goal to scrutinize and lay bare scientific conventions that are taken for granted, tacit knowledge, vested interests at work in neuroscience research or their impacts on people, opens up complex questions about norms. In order to identify social pathologies or "system malfunctions," any critical endeavor will inevitably operate in a normative space, reflecting particular assumptions about the conditions for both social organization and individual wellbeing. What we deem "pathological" depends on a contrast with non-trivial ideas of a non-pathological alternative—such as a well-functioning institution or, where individual subjects are concerned, an orientation

towards an image of the "good life." However, no version of a critical neuroscience should simply impose a set of normative standards or values. Norms are ubiquitous, operative at any time, on various levels, in all forms of social organization, social practices, and individual ways of life. The critic's task in the first instance is to render these norms explicit, point to possible tensions between different normative outlooks, and, where necessary, measure institutional realities against the normative assumptions that legitimate them. This will raise questions of power, the constructions of expertise, the social distribution of knowledge, and the possibilities for participation in decision-making processes. Critical neuroscience thus needs to engage with the current debates about the transparency, accountability, and inclusivity of the new "science in society" communicators, and, not least, to examine their role (Strathern, 2004).

The last few years have seen a steep increase in numerous forms of popularization of neuroscience. Driven by various parties, including neuroscientists, funding agencies, and the media, public engagement in neuroscience has emerged in the form of outreach projects, popular science writing, and—not least—as interactive neuroscience exhibitions geared towards a range of audiences, with the aim of informing (and to varying degrees engaging) the lay citizen. If critical neuroscience advocates informed participation in the scientific process, then it will need to confront questions about representation, expertise, and agency of lay citizens, particularly in information societies characterized by a more demanding and active citizenry (Beck, 1997; Giddens, 1991). There is no doubt that efforts to "democratize" scientific processes this way pose difficulties. With hindsight, earlier optimism about the potential of a renewed politicization of society around issues of science and technology seems to have been premature (see Kerr & Cunningham-Burley, 2000).[13] Rather than an emerging "sub politics" (Beck, 1997)—grass root political engagement that responds to hazards of scientific and technological development—we increasingly witness restricted expert circles monopolizing the negotiation and regulation of relevant issues.

One way for critical neuroscience to attempt to establish (or challenge) normative conceptions—themselves always necessarily under reflexive scrutiny—is by creating a discursive space for debate both in professional and practical domains about the categories and applications of neuroscience, and about related social issues such as the organization of labor, conception of health and disease, goals and practices in parenting and education, issues about law and punishment, technological self-optimization, and much more. In order to make this move however, it needs to probe critically at ways in which the choices and views of the public are regulated, particularly amidst the growing clamor for "neurotalk" in public spheres (Illes et al., 2010). Expert counseling and state-run programs of screening and risk assessment (Rose, 2010), and the instant professional take-up of ethical concerns into an institutionalized "neuroethics" (de Vries, 2007), increasingly occupy the space for public engagement. In what ways might the space for "science in society" or neuroethics experts, as well as the domains of psychiatrists, doctors, and educators (connected to government, funders, or companies) act as intermediaries in aligning public opinions with scientific

[13] Probably the most optimistic voice in this area has been German sociologist Ulrich Beck, see Beck (1995, 1997) and Beck's opening essay in Beck, Giddens, & Lash (1994). See also Giddens (1991, ch. 7).

agendas, ratifying or legitimating neuroscientific research programs (Rose & Miller, 1992)? Who can legitimately make knowable what the public wants or thinks about neuroscience and its applications? How can participatory approaches avoid opening up new forms of stratification?

With such problems in mind, critical neuroscience aspires to open up discursive spaces that facilitate debate among practitioners, "stakeholders," and lay citizens about the goals, concerns, and normative standards that society wants its science to pursue or live up to: where the work of the critic involves not merely encouraging the accessible promotion of new ideas from neuroscience, but invites plural viewpoints and promulgates a degree of critical rigor through provocation—that is, by illuminating blind spots or limitations and by questioning assumptions and applications. It is vital that public neuroscientists conceive of audiences not as listeners or viewers but as potential speakers. It is at these sites of contestation that specific normative issues surrounding scientific matters of concern can emerge and take shape. This process pushes science beyond reliable knowledge—subject only to validation within its own disciplinary context—to the production of "socially robust knowledge;" that is, knowledge tested for validity both outside and inside the lab, developed through the involvement of socially distributed experts including those from different disciplinary and experiential backgrounds within and outside of academia, and knowledge produced through repeated testing, expansion, and modification (Nowotny, 2003). While the embeddedness in society and the iterative process of open contestation may render this knowledge more robust, the means of such forms of polycentric knowledge production in neuroscience must be carefully worked out (Jasanoff, 2003).

A model of "public" neuroscience such as this faces challenges within the changing structure of the university and changes in the organization and funding of professional research. Both are increasingly oriented towards a corporate, neoliberal management model (Giroux, 2007; Mirowski & Sent, 2005). How can critical neuroscience reach its goals in a system that places its values on outcomes and efficiency, increasingly fosters commercializable or applied research, and encourages corporate influences in the form of sponsorship, company spin-offs, profitable patents, and institutional joint ventures?

There are trends pulling neuroscience in different directions, certainly not all negative—a push towards applications and intensified collaboration can also bring synergies and create new perspectives. The ambivalence of the situation can be illustrated by reference to interdisciplinarity (a term that has become a powerful buzzword in academia, including neuroscience). Successful integration of distinct perspectives and methodological approaches can lead to unforeseen benefits and novel insights. However, genuine inter-, trans- and postdisciplinary research is constantly forced to acknowledge, and to work with, tensions between ontological and epistemological frameworks, and is thus necessarily slow, compared to conventional single-discipline research processes. The sustained and, as it were, "organic" integration of different disciplinary approaches and conceptual frameworks will be difficult in outcome-oriented environments dominated by short time frames and institutional structures of commercialized or translational research. In order to enable a reflexive ethos, and to keep open a space for critical inquiry in a context that favors "outcomes" in

terms of revenues and commodities, and entrepreneurial over critical skills, critical neuroscience will need to continue discussing and analyzing structural transformations, and challenging the increasing dominance of market orientation in the wider academic arena.

What Difference Can Critique Make to Neuroscience?

The metaphor of the *looping journey*—of that which is taken to be a "brain fact"—can help to operationalize critique, opening up the many possibilities for thickening, or assembling, a given brain-based phenomenon. Whether we focus on the neural basis of addiction, depression, adolescence, culture, gender, morality, or violence, the journey can be traced using multiple methodologies, from the point of a theme's entry into—and treatment in—the lab, through various technical and knowledge practices, to the interaction with the media and policy, to its reception by the public. What we mean by a "brain fact" is not an absolute thing-in-itself, but a specifically conceptualized phenomenon or "local resistance" that emerges from the collective practices and directed cognition of neuroscientists working in a community at a given time and in a given context (see Choudhury, Nagel, & Slaby, 2009).[14]

With this in mind, it is important to ask what difference second-order observations of laboratory conditions, communities of scientists, and historical and cultural contingencies make to neuroscientists themselves, whose goal is to develop and test paradigms that ultimately contribute to mapping social, cultural, or perceptual processes on particular brain regions. Critical neuroscience renews the possibility for critical commentators to be engaged with, rather than estranged from, laboratory science. Functioning through the collaboration of work from multiple methodologies, it aims to find entry points for social theory, ethnography, philosophy, and history of science, in the laboratory. In the following, we put forward ways in which the latter fields can play a contributory role in both the *practice* of neuroscience in the lab and in the *representation* of neuroscience beyond the lab.

From educational initiatives for junior level researchers to the development of collaborative working groups[15] investigating behavioral phenomena from different disciplinary perspectives, critical neuroscience explores whether a kind of reflexivity can, through interdisciplinary training, be inscribed into experimental practice. The aim here is not to conduct a purer or "better" neuroscience. Instead, reflective practice includes social and historical contextualization and cross-cultural comparison of behavioral phenomena, within neuroscience. Examining these contingencies will

[14] We use the notion of a "brain fact" analogously to Ludwik Fleck's conceptualization of a scientific fact in his seminal study *Genesis and Development of a Scientific Fact* (see Fleck, 1935/1979). On the looping journeys of scientific facts in the context of neuroscience see also Dumit (2004).

[15] Since the emergence of critical neuroscience a handful of joint education opportunities have been started for junior researchers from diverse scientific and academic fields. Pursuing this through graduate courses, themed summer/winter schools, and collaborative workshops will sustain mutual learning and joint work on a number of themed topics related to neuroscience. See www.critical-neuroscience.org for upcoming activities.

generate alternative possibilities for findings in neuroscience, which on the one hand open up interesting empirical questions for neuroscientists, and on the other hand, function as a form of critique from within.

How should we conceive of the relationship between first-order (descriptions of brain and behavior) and second-order (descriptions of neuroscientists observing behavior) observations (Choudhury, Nagel, & Slaby, 2009; Langlitz, this volume; Roepstorff, 2004)? We believe engagement between these socio-cultural and historical studies and experimental neuroscience can be constructive in a number of ways:

(i) demonstration of alternative possibilities of results of neuroscience experiments by modifying technical parameters or comparing and re(de)fining categories;[16]
(ii) exploring routes to empirically investigate social and cultural phenomena without assuming universal neural mechanisms from the outset;
(iii) enriching behavioral theories by allowing for pluralistic viewpoints and methodologies to result in layered explanations of complex phenomena; and
(iv) examining the subtle relationship and feedback loops between popular opinion or ideologies about the brain and findings in neuroscience.

Such goals can only be realistically achieved through collaborative work. Working groups, as initiated since the emergence of critical neuroscience, consist of the following.

Sociologists of science who observe communities of scientists and capture the thought styles that govern their cognition in studying the particular phenomenon in the lab (Fleck, 1935/1979). Fleck described the "tenacity" of systems of thought that govern scientific practices and explanatory styles, and that ultimately give rise to what from then on will count as fact. What solidifies a local resistance into a recognized "fact"? By studying the journey of a phenomenon in and around the neuroscience lab, we can study how the methods, concepts and theories involved in the development of a fact of neuroscience may be culturally conditioned; in addition we can identify the refractory effects of the thought collective that sustain it and the wider culture in which it functions (see, for instance, Dumit, 2004, this volume; Joyce, 2008). Neuroscientists are working at a time of unprecedented politicization through the commercialization of research (Wise, 2006), and sociological analysis can highlight the pressures that commercial, pharmaceutical, and military interests place on neuroscience (Greenslit, 2002; Healy, 2004; Moreno, 2006). Moreover, sociologists can begin to draw cross-national comparisons of the social structures of neuroscience. Comparing the international contexts of trends in neuroscience research and its representation will help to spell out the logic of the neuroindustry, that is, the institutional, historical, political, and ideological planes in which the rapid developments, the allure, and the influence on cultural formulations and other academic disciplines take place, over and above the events within neuroscience per se.

[16] This is an example of how neuroscience itself can be used to subvert its own assumptions and demonstrate the contingencies of categories and methodologies it employs, a move we have called experimental irony. In Chapter 13, Daniel Margulies illustrates the power of this strategy of critique "from inside" through a review of the recent study by Bennett, Miller, & Wolford (2009) that used a dead Atlantic salmon in an fMRI scanner to highlight the high possibility of red herrings in brain imaging research.

Philosophy contributes the analysis of central phenomena under investigation (and their different, often competing, conceptualizations); for example, emotions, moral decisions, and responsibility. It also serves to clarify the content and status of notions such as determinism, reductionism, specificity, and consilience—concepts that have been floated in neuroscience and its critiques for a while, and require sharpening. Often, these and other concepts play key roles in what Hartmann (this volume) calls the hidden hermeneutics of the neurosciences: structural narratives that practitioners routinely employ as they describe their objects of investigation and construct interpretations of data, but that are rarely reflected upon explicitly. Ideas about "cerebral subjectivity" (Vidal, 2009) or the ubiquitous but often vague appeals to evolutionary theory are good examples (Richardson, 2007); similarly the new hype around the notion of cerebral plasticity (Malabou, 2008).

The task here is to elucidate a specific meta level: ascending from the manifest contents of theories, explanatory frameworks, and core concepts in current neuroscience to the analysis of latent assumptions and formative backgrounds, such as the implicit construal of the brain as the stable ontological foundation of both personal traits and social and cultural phenomena (to name just one, albeit crucial example). Philosophy also contributes to enriching the description of phenomena under study through phenomenological investigations, performing what has been called "front-loaded phenomenology" (Gallagher, 2003, this volume; Gallagher & Zahavi, 2008; Ratcliffe, 2008, 2009; Zahavi, 2004).

Cognitive neuroscientists contribute to technical and conceptual analysis of research processes, including methodological assessments. What are the potentials and limits of specific methodologies or tools such as fMRI and the associated statistical methods, and to what extent are these clear or made clear in different venues (Logothetis, 2008; Vul, Harris, Winkielman, & Pashler, 2009)? How are cultural, psychological, functional, and genetic models of cognitive phenomena mapped onto each other? Once a phenomenon enters the neuroscience lab, how do scientists break down the phenomenon into constituents that they are able to study within the constraints of their methodology? What efforts are involved in setting up experimental apparatuses and stabilizing the phenomena under study? Do researchers employ concepts that are sufficiently precise and that fully encompass the relevant dimensions of the phenomenon under study? How are the results analyzed and evaluated in comparison to other data from different experiments? How can data—quantitative and qualitative—from social science and humanities disciplines be brought to bear on the neurobiological results?

Cultural or medical anthropologists will draw on ethnographic data to develop cross-cultural comparisons of behavioral phenomena or symptoms and experimental paradigms (tasks, questionnaires) that have largely been studied on—or standardized using—particular groups of subjects deemed to represent the "norm" (Henrich, Heine, & Norenzayan, 2010).[17] Critical neuroscience draws on medical anthropology

[17] In their recent comparative article, Heinrich, Heine, & Norenzayan (2010) use the acronym WEIRD to denote the White, Educated, Industrialized, Rich, and Democratic societies that behavioral science researchers take to be "standard subjects," in spite of the considerable heterogeneity across populations taken to be groups, and in spite of the fact that so called WEIRD populations are frequently *unusual* or *outliers*.

to supplement findings of neural correlates with phenomenological insights, biographical accounts of the person, and the *meaning*—that is, the social, cultural, moral, or spiritual significances—of behavioral phenomena, including mental illness and interventions (Cohn, this volume). Critical neuroscience resonates with cultural psychiatry, in emphasizing that the most fundamental level, using neuroscience in its current form, is not necessarily the most appropriate either for explaining or intervening in psychopathology. While neuroscientists and medical practitioners increasingly invoke the use of neuroscience in psychiatric nosology and clinical practice (Hyman, 2007; Insel & Quirion, 2005), critical neuroscience must find ways to consider how "meaning and mechanism" intersect via the brain (Choudhury & Kirmayer, 2009; Seligman & Kirmayer, 2008; Wexler, 2006).

The new subfields of social and cultural neuroscience have indeed just begun to investigate how aspects of cultural background may influence cognition, such as the expression and regulation of emotions and understanding of others (Chiao et al., 2008; Han & Northoff, 2008; Zhu, Zhang, Fan, & Han, 2007). As this area of neuroscience burgeons, critical neuroscience looks to anthropology to contribute to the conceptualization of culture in experimental design and interpretation, to explore how environmental factors, including culture, shape or interact with the development of structure and function of the healthy nervous system in such a way that several vocabularies of description—social, cultural, psychological, and biological—can coexist (Kirmayer 2006; Langlitz, this volume; Lock & Nguyen, 2010).

Historians of science trace historical trajectories of the conceptual construals, interpretive contexts, and experimental set-ups common to contemporary neuroscience (Foucault, 1973; Hacking, 2002; Young, 1995). Historical analysis will thus show how particular problems such as the criminal brain, posttraumatic stress disorder, the risky teen, or the empathic female become questions for the neurosciences and how particular methodologies are valued over others as more objective. Critical neuroscience will yield important insights from the history of concepts, practices, and objects of scientific inquiry, to understand how technologies, political, and moral contexts converge to give rise to diagnostic categories, how aspects of the self have come to be objectified and considered in certain contexts as clearly reducible to the brain (Vidal, 2002, 2009) and how scientific objectivity itself developed as an epistemic virtue (Daston & Galison, 2007). Longue durée analysis can additionally serve to interrogate the air of radical departure that surrounds much of the rhetoric around neuroscience (Borck & Hagner, 2001). Unpacking these histories might help to gain distance from the inflated, spectacular, and brain-centric rhetoric which parts of the neuroindustry seem to dictate (Stadler, this volume).

Conclusion

We have sketched a picture of a critical neuroscience that probes the extent to which claims *about* neuroscience do in fact match neuroscience's real world (social) effects. It sets out to analyze the allure and functions of the *neuro* in the broader scheme of intellectual and political contexts including the rise in recent years of a new (neuro) biologism in many academic disciplines and popular culture at large. Our aim is to

contribute these observations from the human sciences to neuroscience so as to demonstrate the contingencies of neuroscientific findings and, at the same time, to open up new experimental and interpretive possibilities.

Assembling and broadening ontological landscapes of behavioral phenomena requires us to move beyond the tenacious nature–nurture distinction when conceptualizing phenomena such as addiction, adolescence, autism, or depression. Instead, critical neuroscience will work with concepts such as "cultural biology" and "local biology" which bring to the fore the co-constitutive relationship between the brain and its context. The "endorphin-challenged alcoholic," the "neurological adolescent," or the "female brain" are richly situated and sustained in a habitat made up of interactions between institutional, cultural, and neuronal infrastructures. Such a framework poses intellectual challenges to cognitive and clinical neuroscience—challenges that must be taken up, especially as the notion of neuroplasticity or the field of cultural neuroscience open up potential to investigate brain–environment interactions. We emphasize the need to rethink the conception and location of these borderlines at the skull or the skin in a way that troubles the arbitrary distinctions and moves beyond biological determinism and social constructionism. If fMRI can show that cultural upbringing modulates brain activity or new biotechnologies permit us to tinker with the brain and cognition, it is apt for neuroscience to acknowledge that our brains are represented in terms of cultural categories and that our brains also do "cultural work" in distinguishing what is natural, who is healthy, different, normal, or rational (Lock, 2001; Lock & Nguyen, 2010).

The chapters in this volume undertake initial explorations of the discursive space that is opened up once the outworn distinctions and dualisms are surpassed, and once open-minded interaction between practitioners from different methodological universes is enabled. The critical ethos we invoke, therefore, is not one that rejects but one that aims to elicit change: both in how social phenomena are explored within neuroscience, and in how the social implications of neuroscience are analyzed. The conceptual changes involved in studying the situated brain in its context, the pedagogical initiatives that bring multiple traditions of scholarship into contact, and the calls for contestation in neuroscience funding and application, all disturb boundaries—between the brain and its environment, between disciplinary vocabularies and methodologies, and between science and society. These very interruptions will provoke us to imagine the brain in different terms and to probe its functions in alternative ways. Such changes—towards which we sense an increasing openness among neuroscientists and social scientists alike—will, we believe, open up potential for a more realistic picture of the function of neuroscience in society while simultaneously commenting on the broader socio-political changes in contemporary societies that steer its developments, for better or for worse.

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