How to Do Voodoo with Functional Neuroimaging.

Par Cornelius Borck

About six years ago, a storm shattered the flourishing field of social neuroscience. Late in 2008, rumours spread about a soon-to-be-published paper that would not just point its finger towards a problematic experiment or identify the wrongdoings of a single scientist, but would accuse more or less the entire field of employing flawed methods. Even before its electronic publication, it quickly migrated across the Internet. This was serious stuff : the paper reported on a meta-analysis of a large number of high-profile papers, published in the most prestigious journals in the field and coming from the elite of the neuroimaging labs. In a large number of these publications, statistical methods had been applied which, according to the authors of the critical meta-analysis, were highly problematic, if not clearly wrong, and that led to exaggerated numbers for positive correlations between psychometric profiles and functional activation of specific brain areas. But above all, the soon-to-be-published paper came with a bombshell title : « Voodoo correlations in social neuroscience ». The neuroscientific community was stunned, engaged in a hectic defence by discussing facts, fears or fiction, while various blogs seized the opportunity to increase the speed and temperature of the debate still further.

In mid-January, the news reached the public. « What were the neuroscientists thinking ? » asked the *New Scientist* in an editorial :

Modern-day neuroscience […] has produced some wonderful science, including endless technicolor images of the brain at work and headline-grabbing papers about the areas that « light up » when registering emotions. Researchers charted those sad spots that winked on in women mourning the end of a relationship, the areas that got fired up when thinking about infidelity, or those that surged in arachnophobes when they thought they were about to see a spider. The subjective subject of feelings seemed at last to be becoming objective. Now it seems that a good chunk of the papers in this field contain exaggerated claims,

according to an analysis which suggests that « voodoo correlations » often inflate the link between brain areas and particular behaviours. (New Scientist, 14 January 2009)

The very next day, on 15 January 2009, *Nature* devoted an entire page in its news section on the story (Abbott 2009), and within a few weeks literally hundreds of public media sites had reported on the « voodoo correlations in social neuroscience »1. The accusations hit like a hammer : they resonated only too well with the mixture of fascination and suspicion with which the media and the public regularly receive the spectacular findings of the neurosciences. Empathy or aggression, fairness or anti-social behaviour — the new visualization method had promised to reveal these as real neurobiological entities instead of mere social constructions. Was all this little more than wishful thinking ? Had the findings, from the outset, been too spectacular to be true ?

Since then the debate has been closed, the discussions are over, the smoke has vanished, the intensity of the fires has been forgotten, and only the story is remembered — even though no paper with the title « Voodoo correlations in social neuroscience » was ever published. The editors of *Perspectives on Psychological Science* eventually requested the authors to change the title into the more sober and respectable « Puzzlingly high correlations in fMRI studies of emotion, personality, and social cognition » (Vul, Harris, Winkielman and Pashler 2009). All in all, the publication had little effect on the practice of functional neuroimaging and hardly anything has changed (Vul and Pashler 2012). The field of social neuroscience flourishes more than ever and its findings are, if anything, just as spectacular. Certainly, the field responded to the critique ; the scientists, accused of using problematic methods, evaluated the critique very carefully and explicitly. This was also a way of containing the storm. They digested the critique to a certain degree and started to employ various correction analyses, but the reported correlations between brain and behaviour are still « puzzlingly high ». Compared to the size of the attack and the weight of the critique, these consequences may be regarded as regrettably small, but it is precisely this resistance on the part of contemporary neuroscience that reflects the field’s dynamic power. And the public resumed to appreciating social neuroscience’s spectacular findings, just as they had embraced the critique

shortly before. The public seems to engage in some form of widespread and fearful appreciation of this sophisticated branch of research. Today, after the debate's closure by a consensus reached among the experts, little appears to be memorable but the lost opportunity to engage critically with exaggerated findings and expectations (Choudhury, Nagel and Slaby 2009).

In light of the minor long-lasting effects, this may be judged as a storm in a teacup rather than a serious debate. However, the events may amount to more than a curious and flamboyant story. In the following, I do not attempt to re-open the debate on voodoo correlations. Rather, I will be looking at it from the point of view of media theory, science studies, and historical epistemology in order to situate the debate on functional neuroimaging within a broader cultural context. There are at least four issues here that deserve attention and which I will briefly sketch out : (1) the inverse temporal order between publication and discussion because of the decisive role of new media and electronic communication in this case ; (2) the multiple levels or modes of critique — assertive as well as performative —, regulating science as a social institution ; (3) the perplexing ontological productivity of social neurosciences, even though the field subscribes to the dominant framework of epistemological reductionism ; and finally, (4) the malleability of the human being and its position in social space in the current « neuroculture » (Ortega and Vidal 2011), opening up what could be called utopian neurofutures.

Temporal Inversion by New Media.

As described above, the final publication of « Puzzlingly High Correlations in fMRI Studies of Emotion, Personality, and Social Cognition » added little to a discussion that, by then, was already over. The printed issue coincided with the closure of the debate. It documented an event that had already taken place ; the printing itself became a gesture of closure, as wonderfully expressed in its first footnote « The paper formerly known as *Voodoo Correlations* ». In a certain sense, the final publication was little more but the printed trace of a heated debate about a paper with a different title — a paper that had become too well known, so much so that the printed version ultimately appeared under a different title and simply documented the leftovers of the debate for the archives.

In the current age of *publish or perish*, the pressure to get a paper out as quickly as possible is strong. Journals have responded to this pressure with the introduction of electronic prepublication and, meanwhile, various alerting services send out emails announcing new publications. Some journals even make the proofs of papers-to-be-published publicly available. Partly due to the opportunities opened by the new publication techniques, and partly to the increased competitiveness of the science market, these transformations of scientific printing and publication are just some aspects of a much broader and generally recognised cultural trend towards acceleration, as famously described by Paul Virilio2. In fact, one could characterize the final, belated and renamed publication of « Puzzlingly High Correlations » as an example of Virilio's concept of an implosion of time, where instantaneous availability eventually results in the standstill of a void.

Perhaps less fancy than such an accelerated time implosion through faster communication channels, but more important from an STS perspective are the multiple consequences of the temporal inversion between publication and critical reception. The paper was made available in its accepted form by the authors to interested colleagues in an electronic format — a practice neither uncommon nor problematic. Within the networks of interconnected computers and new media, however, this quickly resulted in a form of public access, because of the rapidly emerging public interest. And the electronic means of communication proved their role worth as a watershed, making this an unprecedented example of scientific exchange. Not only did the paper circulate much faster and more widely than in conventional paper form, but so did the questions, doubts and signs of irritation bouncing back and forth between authors, readers, commentators, bystanders, etc. Blogs turned into hubs of scientific exchange and became an important arena for staging a scientific dispute about « Voodoo Correlations ». In the final publication the paper was followed, according to customary practice, by selected responses from the different groups of the neuroscientists who had been accused and by a reply from the authors (Diener 20093). But the discussion itself had migrated almost entirely to social media and to its resonances in the broader public in the form of headlines and stories in popular science magazines and the public media in both electronic and printed form. Social media and social neuroscience are two new realms, very real yet

constructed, full of intrinsic activity and resonant effectiveness.

This change in the media participating in the debate had further implications for science as a social institution, beyond accelerated circulation and increased outreach. New and different groups engaged with, and became involved in, the discussions. Compared to previous scientific debates that traditionally centred on expert circles or learned societies, and hence entered the public realm in a more mediated, controlled fashion, the social media imprinted new rules on the debate. Here, the discussion jumped to public attention within just one or two weeks after a single text had been made available, and this suddenly turned a scientific question into a discussion in the public space. In addition, different rules applied to this open debate, as tellingly illustrated by the large number of explanatory descriptions, commentaries, and endless personal comments on almost every so-called expert statement — and all documented and instantaneously available on the Internet.

Science has always been part and parcel of the society in which it takes place, even if it is being pursued in secluded laboratories with highly restricted access. A plenitude of connections and systems interlink the two to a seamless web : scientists bring society and culture with their views and attitudes into the laboratory, and society also uses scientific technologies elsewhere or engages in similar epistemologies in different arenas. Here, however, the participants and the public responded immediately, making the interconnectedness of science and society almost tangible. Although the discussion happened primarily in blogs and centred around a rather technical issue, namely the problematic limitations of particular forms of statistics, the general relevance of the issue at stake was widely acknowledged. Regardless of its technicality, many different voices took an active part in the discussion on science blogs, thereby changing its tone, affect, dynamics, rules, etc. Rarely had it been so obvious how access to scientific debates decides who is participating, what is being voiced, and who is listening.

Given the minor effect of this public debate on the ensuing scientific practice, however, it may be concluded that these changes in media and public participation did little to influence social neuroscience. But from a media theory

perspective, the involvement of new media and science blogs demonstrates an important trajectory of the debate, that will eventually be decisive for scientific debates in the future : scientists did not so much decide among themselves by taking recourse to their expert knowledge, but had to carefully intervene in an open debate and orchestrate their responses so as to regain and maintain a monopoly on the decision of the debate among themselves. The first defensive lines of response, taking the accusations very seriously, proved decisive as they helped the accused scientists to regain control.

Modes of Critique.

The issue at stake was a fairly simple observation. Studies in the field of social neuroscience regularly reported high correlations between a social parameter as measured by some form of psychometric testing, and a particular brain activation as observed by functional imaging. A single study may come up with a correlation higher than expected but, over a longer period, reported findings should consolidate within a range appropriate for employing such sophisticated methods and certainly not higher than for any single method used within the study. Alerted by such considerations, the authors of the « Voodoo » paper inspected the publications reporting puzzlingly high correlations more closely. What they found was that some of these papers described in their methods section a two-step process in which so-called « regions of interest » were first selected from the masses of functional imaging data, before the correlations were then calculated only on basis of these pre-selected data and the socio- or psychometric scores. From this observation, the authors concluded that these papers published inflated numbers.

Social neuroscience is a hot area of scientific research that promises to substantiate socially highly relevant and subjective perceptions, feelings, motivations, etc. as objective, observable, and neurophysiologically grounded facts. To do so, the field combines personality tests, questionnaires on emotional reactions, or psychometric scores with data on brain activation ; the studies thereby bridge from psychological measures to brain metabolism. Both arms of this experimental design have their own problems, and the established research methods have certain, typically well-known limits of reliability. Integrating the two

approaches in a complex experiment obviously increases the difficulties and, hence, the correlative strength of the overall experiment should be smaller rather than larger than the reliability of the individual methods. Somewhat mysteriously, however, this was not the case in social neuroscience, where it transpired that many groups reported very high correlations, eventually approaching 1.0, i.e. a stable link. These groups were using regions of interest, pre-selected from the very large number of cerebral blood flow data for their positive results, and were doing so in order to limit statistical calculations to the meaningful. The discussion quickly revolved around the question of whether this pre-selection of data was acceptable for evaluating experimental results in social neuroscience (Kriegeskorte, Simmons, Bellgowan and Baker 2009).

The argument as presented in the « Voodoo Correlations » paper was a refined blend of fresh curiosity and carefully orchestrated attack. As the story goes, it started with the naïve but well-aimed scepticism of the novice. A young, ambitious and critical MIT student, enrolled in graduate school for a PhD in cognitive sciences, wondered how the combination of two somewhat soft, or at least complex, methods could possibly result in studies with a higher reliability than any single part of them. This was the fresh-curiosity part, next came the attack. Instead of quietly searching the literature for possible justifications for the pre-selection or interviewing statistics experts employed in social neuroscience, Ed Vul (the graduate student who was to become the first author), his supervisor and a colleague sent out a questionnaire to the authors of more than 50 publications, inquiring about the details of the evaluation methods used and asking for justification. Most of the labs responded and confessed to the pre-selection strategy (if they had not already done so in the methods section of the published paper). So by this single stroke, the entire field had been successfully alerted to something in the air. The next was to follow in the paper ready for publication.

The « Voodoo » paper framed the story as a purely scientific question, apparently alerting the audience to the problem of non-independent parameters for correlation statistics. An appendix, however, listed the entire set of 53 incriminated papers with the names of all authors, thereby clearly personalizing an allegedly abstract and theoretical problem. This twist between an abstract

rhetoric of truth and complex social interventions characterized the debate on all levels. Vul played his role as a whistleblower in the name of critical science, thereby forcing his adversaries into action, while, at the same time, he carefully prepared for the storm. Thus « gently » pushed, the accused responded in timely fashion in the mode of scientific discourse among experts by acknowledging the problem in general and by referring to intricate details of a complex matter in particular (Jabbi, Keysers, Singer and Stephan 2009). With this double-edged response of taking responsibility and questioning the justification of the critique, the accused scientists reclaimed their authority as experts in the field by subscribing to a position of scientific rigour, even though they had been accused of publishing flawed results. And both sides together demonstrated, inadvertently or not, an almost perfect operation of the auto-critical function of the system of science, its mode of advancing by critique, careful scrutiny and discussion. The young graduate student was bold enough to accuse the stars in his field, and he was right to do so, because he acted in the name of science, in the name of its truth principle, and he did so with a publication accepted by peer review. And in consequence, he was not punished or ostracized but, on the contrary, offered a job ; he now has a tenure-track position at USCD.

Within the framing Vul and his co-authors gave their publication, the problem at stake was a matter of principle, a truth question with yes or no as the only possible answer. Either Vul was right and many labs used unsound statistical methods (with or without the intention to deceive), or his argument did not apply because he misunderstood the matters involved. In addition, the core of Vul’s argument was straightforward, easy to understand and truly challenging. The critique seemed sound, as quickly realized by the accused imaging scientists. Apparently, there were serious fears among the accused that the public might turn against them and that the funding agencies would withdraw their generous support for an expensive branch of research. This did not happen. The scientists managed to re-establish their authority on all technical questions concerning their field, regardless of the alleged straightforwardness of Vul’s argument. In a first step, after the general acknowledgment of this as a serious issue and a difficult problem, statisticians addressed the new objection as a problem that was well known to the specialists of correlation calculations (Lieberman, Berkman and Wager 2009). Succeeding with this move, it was fairly easy to convince at

least the majority (and the funding agencies) that they, the specialists, were taking care of the problem in responsible ways.

The final act happened in the form of another public event : the famous story of the dead salmon, the « salmon of doubt » (Margulies 2012). Alarmed about the potential problem, another functional imaging team re-analysed, using another statistical method about which doubts had been raised — multi-variance analysis —, a series of data taken during test sessions from a fish, a dead salmon, for adjusting the imaging system. Admiring the beauty of the anatomical scans from the fish, the authors learned to their surprise that it was, indeed, possible with some clever statistics to calculate correlations indicating social interaction between the experimenting scientists and this poor creature (Bennett, Miller and Wolford 2009)4. With a voice of attentiveness to the problem, and apparently to alert their colleagues, they presented the re-calculation at the next meeting of the Brain Mapping conference, where outgoing president Rainer Goebel decided to include this poster in his concluding session as a tongue-in-check response to the debate : who would mistake a dead salmon for a fellow human being ? When the scientists realized that they had regained their position of dominance, they were able to embrace half-ironically an official recognition of the problem. Thus, the salmon became the field's final statement, as everyone understood that it was time to take a breath.

New Ontologies within a Reductionist Epistemological Framework.

From an epistemological perspective, another consequence of the flourishing of social neuroscience is particularly noteworthy. Although never explicitly addressed during the debate, it certainly contributed to the turmoil the Voodoo paper caused. Social neuroscience attracts enormous attention because it produces fascinating results, data that are at the same time significant for the scientific community and meaningful in the eyes of the general public. With social neuroscience, scientific research finally addresses questions of general interest by means of scientific research and in a style apparently directly relevant for society at large : social neuroscience reveals social cognition to be something

materially real, neurophysiologically realized, regardless of questions of cultural relativism or social constructivism.

This research operates within a strictly naturalizing epistemology. Social neuroscience does not populate the world of human beings with mysterious objects of an unknown quality or dubious ontology. On the contrary, it demonstrates these entities to be proper neurophysiological states with well-defined cerebral substrates in the form of specifically activated brain regions or neuronal networks. In this regard, social neuroscience functions under the paradigm of the reductionism that has been driving basic research in the neurosciences for more than a century. Just as neuroanatomists identified the brain regions responsible for sensory processing or speech recognition during the 19th century, their contemporary colleagues dissect the functional anatomy of the brain into its finer and more sophisticated social operations. On the horizon, the old dream of deciphering the brain as the fundamental machine in charge of all higher human activities appears close to becoming true.

A while ago, the advent of functional imaging rekindled older debates about free will and human intentionality. Benjamin Libet felt forced to formulate a complex theory of vetoing in light of the experimental evidence from his quest for the functional anatomy of human decision making, and many colleagues discarded human freedom altogether. Meanwhile, the fierceness of the discussion appears to have died down ; the radical reductionism of the days of the *Decade of the Brain* may not have disappeared entirely, but it has certainly lost much of its appeal. Social neuroscience is the game of the day. It does not address exactly the same issues, as there is no search for freedom or the centre of decision-making, but it shows a remarkable interest in specific states of consciousness. Obviously, social neuroscience is not about to declare social cognition to be something immaterial or spiritual outside of human brains, but it demonstrates that meditation and other spiritual practices affect the human brain physiologically. It even takes a somewhat reserved position on psychic interactionism ; it certainly demonstrates social interaction to cause distinct responses in human brains, but it does not arrange this evidence into a revival of an old-fashioned dualism arguing for some form of psychic causality beyond physiological mechanisms. Social neuroscience does not engage in any

psychism of this sort. Social neuroscience operates from A to Z in a naturalized epistemology ; its tool for objectifying emotions or acts of cognition is the algorithms sorting the raw data from the scanner into patterns of functional activation.

Along this trajectory, however, social neuroscience populates the world with a surprisingly large number of entities that hitherto had been regarded as of ambivalent if not dubious ontological status, clearly falling outside the realm of material objects5. Before functional neuroimaging, there was no conceivable way of determining fairness as an objective brain state, for example, apart from Franz Joseph Gall's phrenological chart attributing a seat in the brain to all desired psychological faculties. With the availability of functional imaging and since the arrival of social neuroscience, fairness, empathy, aggression or revenge have been characterized as specifically determined, functional human brain states. Social neuroscience has made these states materially real as specific activations of neuronal circuits. As they enter the chain of transformation into scientific objects, in the terminology of Hans-Jörg Rheinberger (1997), the epistemic things within social neuroscience research become further stabilized as natural entities. One good example is the « reward system » : introduced by Old and Milner (1954) in studies on electrical brain stimulation in rats, the term proved transferable to humans and took on a life of its own, gaining much momentum with the availability of functional neuroimaging (Kringelbach and Berridge 2010). As a concept, the term « reward system » refers to strictly anatomical structures, but it identifies them as functional units that operate according to psychological laws and social mechanisms.

From an analytical perspective, these new developments are encompassed by the overarching naturalized epistemology. One may even argue that this research still pursues the agenda of epistemological reductionism. But at the same time, it extends the realm of natural objects constituted by scientific research into the social domain, thereby producing a new ontology. Functional neuroimaging creates new families of hybrid objects, truly social constructs and truly scientific objects, furnished with a natural basis by the neurosciences. They are nature/culture hybrids. They share their nature as hybrids with many objects currently under investigation by the sciences, which have come into being as

constructed natural objects by means of the techno-scientific arrangements of experimental practices — as observed by philosophers and sociologists of science, from Gaston Bachelard (1985) to Bruno Latour (1993). But perhaps they are hybrids in a new form, since they are not artificially or technologically created in the same mode as other natural objects. Like genes or quarks, « empathy » relies entirely and exclusively on a complex ensemble of techno-scientific practices that bring it into existence as a naturalized entity and stabilize it as a scientific object ; but unlike genes or quarks, « empathy » arrived in the lab from the life-world of modern society. Social neuroscience operates almost in reverse, taking its objects from the realm of culture and turning them into natural objects. In addition, these newly naturalized objects established by social neuroscience are supposed to function in the physiological spaces of the living brain, in the visualization practices surrounding the scanner and, on the macro level of human interaction, according to the symbolic logic of culture. In this regard, social neuroscience establishes natural objects with more-than-natural qualities. Very generally, functional neuroimaging brings artificial neuroscience and dead brain sciences closer to life and to real-life human beings ; it literally animates the objects under investigation by linking a perfusion pattern with psychic, social and cognitive significance (Borck 2012). « Animism » is an outdated word from anthropology for describing such practices of creating more-than-natural natural objects. It comes in many forms, and recent cultural studies have argued for a re-evaluation of its all-too-swift dismissal as a falsely primitive concept (Batalha Viveiros de Castro 2004, Ingold 2006). Read in this context, the title of Vul's paper acquires another layer of meaning, giving another twist to the debate, as discussed here.

Utopian Neurocultures.

In « Voodoo correlations in social neuroscience », Ed Vul and his co-authors used « voodoo » as a stigmatizing label, dramatizing their accusations as a fight against uncritical and non-scientific activities within the sciences6. Although they lost the debate, they succeeded in gaining enormous attention and, for Vul, winning professional recognition. But what exactly is the result ? The scientists accused by Vul and his co-authors of wrongdoings convinced the public that their

science was sound and, as a consequence, that allegedly voodoo correlations had to be taken seriously. So Vul was right and wrong at the same time, but in a more sophisticated way than he had anticipated and had styled his attack : voodoo, inappropriate as an accusation of wrongdoing, re-enters the discussion somewhat surprisingly as a descriptive category for scientific practice in social neuroscience. Scientific research by means of functional neuroimaging constitutes animated natural objects — and the scientists, together with the general public, happily embrace it for precisely this effect : until recently, neuroscience found inanimate neuroanatomical or neurophysiological substrates wherever it searched in the psyche, but with functional imaging, specific patterns have become the substance of psycho-social life.

The problem, however, arises from pursuing this research within naturalized epistemology, as this framework accommodates the multiple cultural effects of voodoo practices only with difficulty. Epistemologically, social neuroscience emerged as an advanced branch of scientific rationality, providing human societies with ever deeper insights into human nature and hence with the promise of more control over it. But what happens if these details of human nature's new inner secrets are cultural artefacts and social constructs in the first place, as in the case of empathy or anti-social behaviour ? With regard to social neuroscience and its effects upon society, this is very much an open question, as we are witnessing only the beginnings of the neurosciences' new animism.

Social neuroscience is but one aspect of a broader shift away from traditional reductionism, still difficult to grasp or fully acknowledge. Fernando Vidal (2009), Nikolas Rose (2010) and others (for example Thornton 2011) have described how the neurosciences mobilize the human brain to function more and more as the centre stage for, and supposed essence of, human nature. Human beings may always have had a brain, but in today's « neuroculture » human beings *are* their brains (Ortega and Vidal 2011). This new and central role of the neurosciences extends far beyond the emergence of social neuroscience and takes many different manifestations : from mirror neurons and neuronal plasticity to distributed intelligence and cloud computing, the ensemble of highly regarded concepts inspired by the neurosciences shares an emphasis on dynamic, non-anticipated and non-anticipatable effects. It is, in this regard, a family of animistic

concepts, derived from advanced research in the neurosciences.

However, as long as this is perceived and discussed solely from the perspective of a naturalized epistemology, it appears as an indisputable advance of scientific, empirical, objective research. The very dynamic of the concepts employed, as observed here in the practice of functional neuroimaging in social neurosciences, escapes such a perspective (Young 2012). The animistic qualities of this line of research transgress the narrow limits of the acknowledged epistemological framework and hence they necessarily go unnoticed, though perhaps not unnoticeable. Occasionally, they may strike like magic, as some kind of return of the irrational, as was the case when someone dared to label social neuroscience « voodoo » and science and the public jumped upon it. There may be different options. The history of media innovations and new visualization strategies offers numerous examples. As early as the 1930s, for example, Walter Benjamin (1991) observed the emergence of film and cinema as public media. Reflecting on the ambiguous effects of the mobilization of seeing by these new media, he expected much from the dynamics of contemporary visualization technology and built his concept of a period-specific optical unconscious around it (Krauss 1993). What film and cinema were in Benjamin's times probably find their equivalent in screens and computers today. Contemplating, furthermore, the liberating powers of new media technologies, Benjamin (1991) speculated about the arrival of a « second » technology, designed not to conquer but to liberate nature and especially human nature. According to him, this would have to be an alliance technology, generating some form of collective innervation and opening up new spaces of interaction and intervention. Are we witnessing a transformation in this direction ? Overcoming the limits of human nature has been an old dream, revived with almost every technological innovation and revitalized in particular with the new biotechnology and IT. New and social media are certainly about to constitute networks of collective social interaction and innervation. At the same time, the neurosciences have embarked on a course away from predetermined programs and towards the plasticity of dynamic, open interactions. The goal of these future neurosciences will no longer be the complete deciphering of the brain's anatomy, physiology or programmed functionality, as these no longer determine anything. The future of the neurosciences thus lies in the open, animated brain. Whether this will also be a utopian brain in Benjamin's sense

remains doubtful as long as the neurosciences seamlessly fit into the global framework of capitalized knowledge markets. Wittingly but unknowingly, « voodoo correlations » pointed in that direction.

Résumé

À partir des discussions suscitées par l'article « Voodoo correlations in social neuroscience », cette contribution propose une analyse épistémologique de l'imagerie cérébrale fonctionnelle inspirée des STS (Études des sciences et des technologies). La série d'événements que cet article a produits en a pratiquement fait un cas d'école du débat scientifique sur les méthodes, les normes et le pouvoir de la science, même si ceux-ci se sont en grande partie déroulés sur les plates-formes de discussion que sont les nouveaux médias électroniques. L'article n'a pas simplement donné un aperçu des règles changeantes de la communication scientifique : le débat qu'il a provoqué a donné une signification épistémologique à cette branche particulière de la recherche. L'imagerie cérébrale fonctionnelle fournit des preuves tangibles aux types sociaux complexes et semble suivre le programme réducteur d'une épistémologie naturalisée. Toutefois, en l'appliquant au social et au cognitif, l'imagerie fonctionnelle entraîne une inflation ontologique d'objets matériels curieusement animés, se rapprochant d'une surprenante renaissance de la pensée animiste. Ces « corrélations vaudoues », utilisées au départ pour dénoncer une rigueur scientifique réfrénée, sont devenues un concept descriptif, incitant à d'autres discussions épistémologiques.

Notes

1 An overview with links to many of the sources is given in the blog *The Amazing World of Psychiatry*. Daniel Margulies has recently published reflections on the events from an insider's perspective; see his « The Salomon of Doubt » in Suparna Choudhury and Jan Slaby (eds.). *Critical Neuroscience : A Handbook of the Social and Cultural Contexts of Neuroscience*, p. 273-285. Chichester : Blackwell (2012).

2 See Paul Virilio *Polar Inertia* (1990) and *The Information Bomb* (1998).

3 The original paper by Vul et al. was followed by eight comments that covered more than 26 pages and a reply by the authors.

4 See also « The Story Behind the Atlantic Salmon » (2009).

5 As far as I can see, the argument I elaborate here was first presented by Martyn Pickersgill (2009), « Between soma and society : neuroscience and the ontology of psychopathy » *BioSocieties*, n° 4 : p. 45-60.

6 Their paper reminded readers of Robert L. Park (2000), *Voodoo science : the road from foolishness to fraud*.

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