

The Experimental Neuro-Framing of Sexuality

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Brain scans of homosexuality, sexual desire and images of male and female brain function are becoming a common element of popular scientific news. How is sexuality re-described and re-produced when studied in brain scanners? This article explores the cultural production of sexuality in the growing field of neuroimaging research. In focus is the neural framing of sexuality, i.e. the process by which sexuality is understood as a matter of brain activity and visualizable with medical imaging technologies. The neuroframing of sexuality enables a reproduction of socio-cultural notions of difference, but also of neuroscience's own notions of agency. The neural framing of sexuality re-mediates an idealized sexuality: ageless, neatly oriented, bodiless although haunted by the de-animated body, unfolding neatly as a sequential response of a psychological inside to an inanimate outside, and essentialized as independent from its feelers and objects.

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Introduction

Can there be a brain image of an orgasm? In contrast to the 1990s neuroscientific research on sexuality which primarily attempted to find anatomical differences between the brains of homo- and heterosexuals or men and women (e.g. LeVay 1991; Swaab et al 1992; analyzed in Stein 1999), the emergent program of neuroscientific research on sexuality in the 2000s aims to map and interpret how sexual desire takes place in the human brain. A sub-product of this process is familiar brain scans where certain regions seem to fire in red and yellow.

With brain research's new appealing technologies, functional neuroimaging methods,¹ scientists from various disciplines have been charting a new territory of their own at the crossroads of neuroscience and sexology, witnessed by the wide range of journals in which such studies have been published: from sexology-oriented (*Archives of Sexual Behavior, Journal of Sexual Medicine, Menopause*) through neuropsychological (*Brain and Behavior*) to neuroimaging journals (*NeuroImage, Human Brain Mapping*).

The brain is an arena where

Western culture expects crucial questions about human subjectivity to be resolved. Concomitantly, we witness the cultural cerebralization (Vidal and Ortega 2011) of human phenomena such as sexuality. How does it matter that the brain is a site where sexuality and human emotions are being explored? How is sexuality transformed (if at all) when studied as something of the brain? More prosaically, what is sexual desire when experimentally framed as something of the brain, i.e. shaped as an object of the new neurosciences?

Neuroimaging Sexuality: Overview

The first neuroimaging study of human sexuality was published in 1988 under the title 'Positron Emission Tomography and Sexual Arousal in a Sadist and Two Controls' (Garnett et al 1988). In the two decades that followed, about 60 experimental articles reporting on neuroimaging research on 'normal' human sexuality were published in scientific journals.² This body of scholarship deals primarily with sexual arousal, but also sexual orientation and orgasm. Most of these medical publications have focused on the brain functionings of non-pathological sexual arousal in men, sometimes in comparison with women.³

Neuroimaging studies of sexuality are based on experiments which share a common frame with functional neuroimaging research

in general. Research subjects and controls are selected, and are asked to perform specific tasks, such as viewing a given sequence of pictures, while lying in a scanner that registers brain activity. The researchers then process brain activity data with statistical methods in the subject group and control group, and create visual displays of the data, the most familiar of which feature areas 'lit up' in yellow and red on a grayscale background. On the basis of the comparative brain activity data/images and statistical analysis, neuroscientists draw conclusions about the differences between subjects and controls, or between different psychological states in the same subjects (Dumit 2004).

A striking feature of neuroimaging studies of sexuality is the kinds of tasks performed during the measurements. In some of these neuroimaging investigations, the research subjects are asked to masturbate or reach orgasm according to a certain timing. In other, more conventional experiments, they are shown pictures with and without erotic content. Sometimes research subjects are asked to report the arousal they experience during the experiment, or bodily measurements are taken for correlation with the brain activity data. The experimental designs vary widely and the reductions, productions and reproductions of sexuality take place at different steps and levels of the experimental settings, which the following highlights.

Ideal Subjects and Ideal Categories of Desire

By procedures of investigation of the volunteers, neuroscientists align the historically new experimental apparatus of functional neuroimaging with classical technologies of sexological investigation like questionnaires and scores to categorize the subjects and their sexualities. In this section I argue that the participants are selected and treated as the bearers of an idealized sexuality.

Ideal Subjects

An early, preliminary study by a French research group (Stoléru et al 1999) is interesting to examine here because of the thoroughness of its description of the selection criteria. The volunteers were 'eight right-handed, physically and psychiatrically well, unmedicated male volunteers who were likely to have intense sexual responses to visual sexual stimuli' (Stoléru et al 1999, 4). The selection of very sexually responsive participants was effected by means of questionnaires: 'only subjects answering they were 'generally' or 'always' aroused by sexually explicit films were included' (Stoléru et al 1999, 5). Additionally, volunteers had to be below 45 years old 'to eliminate possible effects of age on sexual arousability' (Stoléru et al 1999, 5). The selected participants were between 20 and 25 years old.

In the second study published by the same research team, the range

of selectees was intentionally broader, 'to increase the generalizability of the first study by including subjects with a larger range of age and sexual arousability' (Redouté et al 2000, 164). This time the participants were between 21 and 39 years old, and they were not selected on the basis of being exceptionally sexual.

In the body of subsequent publications in the field, most experiments were designed with participants between roughly 18 and 40 years of age; in half of those, the participants were between 18 and 30. Often, only the data in participants with a 'sufficient' level of arousal is kept. Even in the publications which focused on a young and narrow age group, there is usually no rationale provided for the choice of age limits. It is as if it was self-evident that sexuality is best studied in people in their twenties.

Of course, there are good reasons to do so. For instance, statistically more performant participants ensure the feasibility of the experiments. My point is, however, that unflawed sexuality is what is studied in twenty-year old males, and other groups can be described by difference with that group. If young sexuality is taken as the best representative of human sexuality, then what the experimenters map, I argue, is a pure sexuality unmarked (unflawed) by age.

Oriented Participants

It is also clear that most published

experiments study male sexual desire; among those, a focus on heterosexual arousal (and/or erection and/or orgasm) is also more common.⁴

Virtually all studies aimed to recruit participants with some sexual experience; exclusively heterosexual, and, when needed, exclusively homosexual⁵ – although this seems to have been difficult to achieve, as we shall now see.

When explicit, the sexual orientations of the participants were established either based on subjects' self-definition or, more commonly in studies with homosexual people, based on more complex assessments such as questionnaires and interviews in which several dimensions of the volunteers' sexuality were assessed, such as past experiences and felt attractions.

For instance, one unusually detailed publication explains that in order to select 28 heterosexual men and women:

subjects were pre-screened to verify that they were heterosexual (self-reported as having only opposite-sex sexual desire and sexual experiences), had experience viewing stimuli [erotica] similar to those in the study, and found such materials significantly arousing. Thirty-four males were pre-screened: four (12%) were excluded because they reported same-sex desire or experience... Forty-five females were pre-

screened: 16 (36%) were excluded because they reported same-sex desire or experience and 7 (16%) ... because of insufficient response to erotica (Hamann et al 2004, 415).

However, not all studies seem to be that strict in their selection. In studies featuring only heterosexuals, the stringency of selection (and in reporting the selection procedures) with regards to sexual preferences varies greatly.⁶

In studies featuring homosexuals, the use of Kinsey scales (Kinsey et al 1948) to categorize an individual's current and past sexual preferences between 0 and 6 was common, where 0 means purely heterosexual and 6 purely homosexual. Attraction or feelings, sexual behavior, and fantasy, are common dimensions on the basis of which participants were attributed a score and selected – or not – for participation. Most often, the participants selected had scores of 0–1 (hetero+) and 5–6 (gay+).⁷

The apparent reason for selecting 0–1 and 5–6 instead of 0 and 6 is pragmatic. Some researchers defend such a choice by arguing that a somewhat loose selection on the scale is more representative of the sexual diversity in hetero- and homosexuals (Paul et al 2008, 731). But mostly, it seems to have been difficult to find participants with a pure sexual orientation, especially amongst lesbians. For instance, Berglund and colleagues (2006)

wrote that '[b]ecause it was important to collect the data from ... subjects within the same period' – i.e. because they could not spend more time looking for the perfect participants – and 'because of the reportedly higher sexual fluidity in lesbian women (a strictly homosexual choice of sexual partner seems more unusual among the lesbian women than HoM) ...', the study group consisted of lesbian women who rated >5 [sic] on the Kinsey scale' (Berglund et al 2006, 8273).

The Unflawed Compass of Sexual Orientation

There is a remarkable contrast between the handling of sexual orientation for selection purposes and for experiment design and interpretation. On the one hand, in the selection tests, researchers often give detailed attention to volunteers' sexual orientation and acknowledge several dimensions of sexual preference (feelings, acts, fantasies, attractions, and even changeability in time). On the other hand, these details are used only to exclude imperfectly oriented volunteers, and the qualitative information on people's sexuality generated for the selections is as good as discarded in the rest of the experiment design and interpretation of results.

This contrast points to an experimental logic: research participants are not interesting for their sexualities; they are interesting as the bear-

ers of idealized and ideally oriented homo- and heterosexuality. Homo- and heterosexuality are idealized by the central contemporary cultural logic addressed by Eve Kosofsky Sedgwick, according to which 'of the very many dimensions' of individual sexual preferences, 'precisely one, the gender of object choice, emerged from the turn of the [twentieth] century, and has remained, as the dimension denoted by the now ubiquitous category of "sexual orientation"' (Kosofsky Sedgwick 1990, 8–9).

The neurostudies of sexuality are not studies of homosexual and heterosexual – nor bisexual – people's lived sexuality; they are, instead, studies of idealized homosexual and heterosexual desire, treated as the only coordinates needed to describe human sexuality. This is not because bisexualities (and diverse sets of preferences) are considered non-existent, but because they are not necessary to the neuroscientific project of describing the main coordinates of human sexuality. To put it bluntly: in the world of neural sexuality, people may well be bisexual, but desire is not.⁸

Philosopher Sara Ahmed writes the following about sexual orientation:

If sexual orientation becomes a matter of being, then 'being' itself becomes orientated... [T]he term 'orientation'... points to how one is placed in relation to objects in

the sense of 'the direction' one has and takes toward objects... So sexual desire orientates the subject towards some others (and by implication not other others) by establishing a line or direction... It is not simply the object that determines the 'direction' of one's desire; rather the direction one takes makes some others available as objects to be desired. (Ahmed 2006, 69–70).

Ahmed goes on theorizing the norm of the 'straight line' and, in contrast, same-sex desire as off line (Ahmed 2006, 71). In other words, orientation is a feature of our being in the world which unfolds in relation to culturally normed life lines.

In the current sexually-oriented world we inhabit, the directions a sexual compass point to are homo and hetero (and to some extent, male and female, as we shall see further on). This cultural logic is reproduced in the neuroimaging science of sexuality, where it organizes the design and interpretation of experiments around an idealized notion of sexuality.

This section aimed to highlight the idealization of the human participants in the neuroimaging experiments. My point is not a criticism of whose sexuality is being studied, but rather what sexuality is being studied as: an ideally oriented sexuality, unflawed by age and bearer. Let us now turn to how, experimentally, this

is done.

Subtractions

Neuroscience treats sexuality as it treats emotions – as processes in themselves which take place within the individual (more about this further on). In his study of neuroimaging experiments, medical anthropologist Simon Cohn (2011; 2008) highlights a general feature of experimental design in neuroimaging science of emotion: the same assumptions about the nature of emotions guide the design, conduct, and interpretation of experiments. Consequently, 'only those elements that can be localized and delimited emerge as components of the [neural] pathways and maps used to represent the experience' (Cohn 2008, 151). Similarly, in neuroscientific work, sexuality is defined through what it is experimentally enacted as (what it is), and what it is compared to (what it is not).

Experimental Productions: That Which Sexuality Is

Sexual desire and pleasure are produced in a range of different ways in the neuroimaging experiments.

The neuroimaging studies of orgasm or ejaculation use direct bodily stimulation such as vibrators (Komisaruk and Whipple 2005; Komisaruk et al 2004) or sex given by a partner (Georgiadis et al 2006; Holstege et al 2003). One study fea-

tured an experimental condition in which the participating women were asked to think themselves to orgasm (Komisaruk and Whipple 2005).

In neuroimaging studies of sexual arousal, the most common experimental situation consists in having participants watch sequences of videos or pictures with 'erotic content' while lying in the scanner. These sequences are usually series of shorter movies or pictures, from a few seconds to several minutes.

Although generally drawing on mainstream pornographic imagery, the contents of the visual materials – and the precision with which they are described – vary across the publications. Often the contents of the films and pictures are labeled as 'erotic' or 'emotionally neutral' but not described beyond indications such as 'featured heterosexual intercourse' (Miyagawa et al 2007, 832). Sometimes, however, the authors make explicit what sexual practices are visible; or in the case of still photos, what poses the bodies represented have. For instance, Beauregard et al describe the videos they used as follows: '[they] depicted different kinds of sexual interactions (e.g. oral sex, vaginal intercourse, etc.) between one woman and two or three men, two women and one man, and between two or more women' (Beauregard et al 2001, 2) Arnou and colleagues describe the videos and their selection as such: 'The content of erotic segments involved

four types of sexual activities: rear entry intercourse, intercourse with the female in the superior position, fellatio and sexual intercourse with the male in the superior position. Of eight different sexual activities depicted in film, these four activities were associated with the highest levels of penile tumescence' (Arnou et al 2002, 1016).

This points to a crucial feature of the experimental design: choosing pictures or videos which produce a sexual state in a predictable manner. Although not a standard procedure, it has become common that the erotic video excerpts or pictures be tested in advance by a test group matched with the group of experiment participants for variables like age and sex (e.g. by seven students in Stoléru et al 1999). In such procedures, the test group is presented with a range of pictures and videos with erotic materials and attribute a grade to those: from not arousing (grade 0) to very arousing (grade 9). From the broad range of graded visual materials, a set of videos or pictures is then selected which fulfills certain given characteristics, such as being equally exciting to men and women, or being very exciting to all, or being slightly exciting. Other studies do not select films on an equalizing basis but monitor participants' arousal in order to compare responses for similar degrees of arousal.⁹

Thus neuroscientists seem to be aiming at producing effective sexual

stimuli that produce sexual activity at a given level of intensity.

This aligns with the circular logic of mainstream sexology, which defines normal sexual response as the response to 'effective stimulation', itself defined as 'orgasm-oriented stimulation that facilitates the human sexual response cycle' (Tiefer 2002, 81). That, in turn, has 'defined sex as what occurs during the response cycle and produces orgasm' (Tiefer 2002, 82).

The great effort deployed by the neuroscientists in experiment design to make arousal comparable across participants and categories of participants, independent of their qualitative relation to pornography and sexuality, reveals an ontological assumption: that there is a universal desire and pleasure which, once triggered, is the same for everyone. The assumption acknowledges that desire and pleasure may have different intensities and possibly different pathways – but no different expressions depending on what triggers it. Desire and pleasure are described as versions of the same thing, no matter if what makes them happen is mainstream porn, gay erotica, nude images, or, in the case of orgasm studies, a partner, vibrator or masturbation.

Implicit Sexological Model

The experimental production of this extensively standardized sexual arousal builds on – and reproduces – implicit categories and models of

sexual arousal.

First, as suggested in the previous section, socio-cultural categories of sexuality and gender come to frame the experiments and the construct of a desiring brain along a series of binaries: a gender binary, a binary of sexual orientation, and notions of normal/impaired sexual function.

Second, sexual desire and pleasure are produced along implicit sexological models, which set up assumptions about the temporality of sexual desire/pleasure. For instance, an implicit sexological hypothesis at work is that participants are turned on in a way that resembles their own sexuality while watching depictions of sexual activity which echo with their own.¹⁰

Just like in any neuroimaging design, experiments are scripted to follow strict timelines: of sequences of stimuli, control and rest conditions, all of which have definite durations and sequential order. For instance, in the experiments by Stoléru et al (1999), 'documentary films showing the Amazonian forest and an island off Brittany' were shown for ten minutes each, then a humor video (ten minutes), then another humor video (ten minutes), then a 'sexually explicit cli[p] depicting heterosexual coitus' (ten minutes), then another ten-minute long sexually explicit film. The sexual condition was the last one in that order because the arousal from it was expected to last longer. The study of orgasm by

Georgiadis et al (2006) had participants follow a strict timeline of rest, imitation of orgasm, clitoral stimulation, and orgasm attempt.

Beyond these temporal choices, there is a crucial, underlying temporal order that organizes the shape of the experiment. Obvious both in the studies of orgasm and studies of erection is the assumption that sexuality (desire and pleasure) follows a sequence of phases: from desire, excitement, through a plateau phase, to orgasm. This is the 'human sexual response cycle model' (HSRCM) originally proposed by William Masters and Virginia Johnson (1966): the normative description of a sexuality as dominantly genital, heterosexual-coital, physiological, and naturally unfolding along this given temporal order.

Masters and Johnson's HSRCM was revised in the 1970s and subsequently included in the psychiatric classification system DSM, which defines sexual dysfunction. Thus it is not surprising that a more or less exact version of it is reproduced in the neuroimaging experiments.

The HSRCM has been criticized by feminist sexologists and allied views for equating sexuality with successful orgasm-oriented sexual activity in a 'linear, genital game plan' (Tiefer 2002, 85).¹¹ Sexual practices not focused on orgasm; pleasure other than orgasm; non-physiological dimensions affecting the possibility of sexual pleasure for many, such as emotions, relations,

communication; and the political etiology of 'sexual dysfunction' i.e. of the variations from the HSRC's norm of what constitutes healthy performant sex, are not visible in this model. Rather, sexual performance is measured, for women, in terms of the frequency orgasm reached, and for men in terms of erection, ejaculation and orgasm.

Tellingly, Masters and Johnson developed their HSRC model on the basis of experiments in which only people with a 'positive history of orgasm' participated, i.e. 'devotees of a particular, goal-oriented sexual style' (Tiefer 2002, 80).¹² This is also the way neuroimaging experiments function. They select participants with a positive sexual history without dysfunction. They design and use 'effective' sexual stimulation, and exclude data from participants who do not perform sexual arousal well enough in experiments.¹³

The culturally dominant HSRCM-assumptions about the nature of arousal thus run through the experiments and become embedded in the neural facts of sexuality which appear as the results of the experiments but are, instead, the results of a self-fulfilling circular embeddedness.

Experimental Productions: That Which Sexuality is Not

Most neuroimaging experiments use comparisons with control conditions in order to produce meaningful data. Neuroimaging data are

relative and acquire meaning first when a specific experimental state such as 'sexually aroused' is distinguished from another, e.g. 'rest' or 'imitation of pleasure'. What counts as sexuality is thus defined as much by what does not count as sexual pleasure/desire.

For instance, in orgasm studies, a control condition used for comparison is sexual pleasure before orgasm (Holstege et al 2003; Komisaruk and Whipple 2005; Georgiadis et al 2006). Another control condition is the 'imitation' of orgasm (Georgiadis et al 2006). This deserves attention: when asked to imitate orgasm, women participants are asked to contract their muscles (both vaginal and other bodily muscles) in a way that resembles what happens for them upon orgasm. By a statistical comparison, called subtraction, between the orgasm data and the imitation data, the muscular body is erased from brain data and therefore only a specifically non-fleshy, non-bodily aspect of orgasm is kept as a brain depiction of orgasm. This, in turn, promotes brain activity to the ontological level of being the site where it 'really' happens.¹⁴

Similarly, in the experiments on sexual arousal, the researchers use as control conditions different experimental ways of having participants doing nothing – in a focused manner. Participants may be asked to stare at a black cross on a white background, or at a monochromatic

green image, or at a blurred 'mosaic' video. In some experiments, an emotional nothingness is produced by having the participants watch 'emotionally neutral' videos such as excerpts from a documentary about the dull landscapes of Brittany. Or participants may be asked simply to breathe quietly.

The subtraction between, on the one hand, brain data produced during a condition of sexual arousal, i.e. watching erotic videos, and on the other hand, a control state, i.e. excerpts from a documentary, yields a 'cleaned up' version of the brain data on sexual arousal. The comparison functions as a removal of unwanted noise such as the changes in brain data linked to the task of watching a movie (independently of its content). The subtraction also erases rest (what counts as rest) from the realm of the sexual.

Additionally, beyond such 'baseline' conditions, more advanced control situations are used in the neuroimaging science of sex. In virtually all experiments, control conditions are chosen which are used by the researchers to identify the specifically sexual component of the sexual response. The epistemologically threatening question is this: What in the sexual response makes it, specifically, sexual and not just emotional (cf. Walter et al 2008)? What is the brain activation pattern which makes an orgasm, an orgasm – and not, say, simply a pleasurable bodily experience?

I tentatively call this an epistemological anxiety of specificity.¹⁵ Control conditions are designed to contain this anxiety. For instance, control conditions for sexual arousal (showing erotica) may be showing images of sports. The rationale varies across experiments. For example, sports pictures or videos are used as control conditions to induce a general but nonsexual excitement (e.g. Arnou et al 2002; Walter et al. 2008); or to elicit a response to viewing nonsexual interactions between bodies (e.g. Ferretti et al 2005; Brunetti et al 2008; Safron et al 2007).

Using subtraction (comparison) between participants' brain data upon sexual arousal and upon viewing sports, respectively, the neuroscientists isolate what they consider a specifically sexual excitement.¹⁶

By the same logic, in the experiment by Stoléru et al (Redouté et al 2000; Stoléru et al 1999), humor clips were used to induce the control states positive and nonsexual condition to compare with showing erotic videos and pictures of sexy women to induce positive and sexual conditions. This is different from the comparison with landscape videos in the same experiment: whereas the landscape was considered to yield an 'emotionally neutral' baseline condition, the humor scenes were handled as a tool to isolate what makes sexual arousal something different from, say, a nice fun moment of laughter in front of televi-

sion.

Of course, many assumptions are at work here about what can or cannot be sexual, or emotional. People are not expected to get aroused by watching pictures of Brittany or when viewing sports. This indicates that the experimental settings reproduce culturally available boundaries of what counts as sexual and, more broadly, as emotional.

In addition to sports, recurrent stimuli and control situations are specifically designed to remove interactions between people from brain data. Experiments use a range of control videos or pictures showing situations defined as 'social interactions' such as interviews, carpentry (Beauregard et al 2001), therapeutic massage (Hamann et al 2004), sports (Ferretti et al 2005), or 'couples during regular nonsexual activity such as gardening, working together, or talking' (Paul et al 2008).

This logic of removing representations of interactions from the brain data is epitomized by the experimental design chosen by Ponseti et al (2009; 2006) who chose to induce the sexual condition by showing pictures of aroused genitals only (instead of pictures of sexual activity). The justification was to avoid the part of the brain response that could be associated with seeing and responding to people's facial expressions and bodily gestures. This approach defines the 'social' brain response as a disturbance of

the data about sexuality.

As a result of such experimental design, what many scholars in the social sciences and humanities would refer to as ‘the social’ is irremediably absent from the experiments’ conceptualizations of desire. But the social is not forgotten or simply absent (cf. Martin 2010; Cohn 2008), it is cleaned up.¹⁷ This cleaning up is, in turn, enabled by an implicit, additive psychological model according to which sexuality equals a core sexuality plus (possibly) interaction. Core sexuality is confined within the individual body.

Of course, the experiment is not a non-social setting. Rather the specific social-material configuration of the experiment is designed so as to produce, by design, and yield, by subtraction, a sexuality cleaned up from (a certain idea of) the social.

Disappearances

The Ghost of the De-Animated Body

The human body of the neuroimaging experiments of desire is visible by its absence from the models of desire proposed. In neural models of sexual arousal, the body’s sexuality consists of being activated by automatic reactions (higher pulse, erection) and by brain arousal (as in Redouté et al 2000; Stoléru et al 1999). The erect male body becomes part of the imaginary of desire which feeds back to the brain:

neuroscientists propose that the pleasant consciousness of erection is ‘visible’ in the brain activation during desire – i.e. the pleasure of desire is the pleasure of feeling one’s body erect (e.g. Redouté et al 2000; e.g. Stoléru et al 1999; Hamann et al 2004).

Here, the brain is given an agency over the person who carries it and who becomes a mere bodily vehicle for that brain. This rehashes the traditional philosophical separation and hierarchy, in Western culture, of the mind-in-the-brain (Beaulieu 2000) over the body, which is crucial to the modern figure of the cerebral subject (Vidal 2009) or of what historian Robert Martensen has called the ‘cerebral body’, the cultural-medical understanding of the body as dominated by the brain (Martensen 2004).

However, the brain activation patterns that match the reactions of the aroused body are those that the neuroscientists consider to constitute the ‘neural networks’ of sexual arousal. The arousable body thus crucially defines the brain machinery of desire. Ironically, the crucial bodily correlations almost never make it to the press releases or media articles where the brain is portrayed as ‘the most important sexual organ’ – to paraphrase the title of a Nature article (Dennis 2004). The material but disembodied desire-in-the-brain is hence a result of an omission of the bodily references used to produce it, a re-enactment of the mod-

ern cerebral subject/body. But the de-animated body comes to invisibly haunt the neural networks of desire.

The Disappearance of the Objects of Desire/Pleasure

In most neuroimaging studies of sexuality, the researchers look for the brain data that follows the increase/decrease of sexual arousal or pleasure.¹⁸ Sexual arousal/pleasure is, in turn, given by 'extracerebral markers of sexual performance and orgasm' (Georgiadis et al 2006, 3305) which are either 'objective' measurements produced by monitoring bodily processes throughout the experiment, or 'subjective' reports of perceived arousal/pleasure. These provide an indirect referent for sexual arousal/pleasure. This non-brain bodily measure then defines experimentally, and quantitatively, what counts as arousal.

Both objective and subjective measures of sexual arousal/pleasure are, by means of quantification, disconnected from the situations that they arise in. In these descriptions of neural networks of arousal, what is left as relevant from the experimental situations is how much aroused the participants become – not what made it happen. Similarly, the orgasm studies do not differentiate between different methods used to stimulate the participants; although the researchers use only one method per experiment (e.g. clitoral stimulation with a vibrator),

they refer freely to other studies which used other methods to induce pleasure or orgasm – such as masturbation given by one's partner.

This quantification is used by the researchers to create commensurability between instances of sexual desire/arousal in the experiment. Commensuration is a social process, which sociologists Wendy Nelson Espeland and Mitchell Stevens define as 'the transformation of different qualities into a common metric' (Espeland and Stevens 1998). The commensuration of different things change our relation to these things as we lose our special relation to them when they lose their integrity: the commensuration of sexuality effects a de-qualification of desire.

What we therefore witness is the disparition of the objects of desire/pleasure in a commensurable world. As we have seen earlier, sexuality keeps an orientation (for an idealized gender) but it loses its 'towardness', its relation to its erotic object (cf. Ahmed 2006; Cohn 2008). Instead, the implicit model at play in the neuroimaging science of sex is one in which situations function as triggers of desire and pleasure: they effectively make it happen without being part of it, without shaping it or our subjectivity. In this model, erotic films, pictures of naked bodies, vibrators, partners and fantasies all function as just different versions of Aladdin's sleeve brushing the lamp. They all unleash the same old genie, always already entrapped in the

individual.

Abstract Experiments: Ideal Sex

The special appeal of neuroscientific reductions of sexuality comes from the world that they are productive of, the stories opened up by the neural models (cf. Martin 2010). They reproduce the promise that we evolve in a world in which there is a pure sexuality, where we move around with this special agency made neural. A world where the drama of emotions unfolds in the convolutions of the brain before it is experienced by the body. This is a world re-centered towards an authenticity gone neuro: a world with the promise of communicating with our true selves, the inhabitants of an 'interior space' (cf. Rose 2007) no longer only psychological but tellingly neural.

To understand this world, we need to engage with the universe of which the reductions operative in the neuroscience of sex are generative. This is what the next sections begin to engage with.

We have seen that not only are the experiments self-referential (they construct and find sexual desire in line with their own definitions of gender, sex and sexuality) but they are 'abstract experiments', to use a term from social psychologist Steven D. Brown (2012). Brown writes about psychologist Norman Triplett's famous experiment about social competition in the late 19th century. Triplett noticed that cyclists

tend to have faster times when biking in a race than on their own. In order to prove this, he designed a laboratory experiment – without bikes. Instead the laboratory settings involved reeling a fishing reel as fast as possible; people reeled faster in the presence of a competitor. There is no similarity whatsoever between bike and reel – but both articulate social competition in the right settings, Brown writes: 'the point is to create something approaching equivalence rather than direct replication in experiential terms. The laboratory task feels something like the bicycle race' (Brown 2012, 6).

In this example, the mode of realism of neuroimaging experiments is not one that seeks to reproduce the sexual world outside of the scanner (the bike race). Rather, the experimental settings are expected to work like the fishing reel: to induce emotional states that 'feel something like' sexual arousal or orgasm. Brown explains that psychological experiments really study aspects of life idealized to an extreme:

It is common to observe that experimentation is reductionist...and that, ultimately, the findings which emerge tell us nothing we did not know already. ...There is, however, a more interesting aspect of this reductionism. Psychological experimentation aims for a certain kind of purity of expression. It does not seek the complexity of social life as it is lived, but rather

the essence of a phenomenon reduced to the simplest possible set of co-ordinates. Or put slightly differently, it attempts to make visible social phenomenon in a form in which they could never possibly be lived, never otherwise made manifest (Brown 2012, 7).

Consequently, the interesting criticism of the reel-study of social competition is not that a reel is not a bike.

Similarly, the neuro-sexual experiments investigated here work with ideal notions of sexual desire/pleasure portrayed in ways they could never be lived: The experimental world of ideal sexuality is made of ideal participants, essentialized desire and pleasure. Ideal sexuality unfolds unhindered as a sequential response of the subjective inside to external stimuli. Ideal sexual desire and pleasure take place as a performant, genital, non-social, focused excitement of the cerebral body. A historically unsurprising version of sexuality: a clean version of Masters and Johnson's sexual response, but crucially featuring the brain. Ideal desire and pleasure are unmarked by age (or actually, by any kind of life). They are triggered by specific situations but not qualitatively influenced by those. Ideal desire and pleasure are thus detached from their feeler and from their objects: unflawed by them, leaving for desire/pleasure a 'core' commensurable phenomenon that seems to exist

all by itself, a latent capacity of the individual brain.

Cleaning-ups of human sexuality (including, but not limited to, the selection of participants and the design of subtractions) enable the experiment to live up to that abstract idealization of desire. There, the brain is given the role of the place where the specific, characteristic aspects of sex, desire and pleasure crucially happen: it is a neurocentric account, where the neuro- and its experimental frames also set the terms in which sexual desire is described.

Appearances: Brain Descriptions of Sexuality

Let us now turn to how sexual desire/pleasure is described when experimented with and given the shape of neural networks.

What is a Brained Pleasure?

The neural framing of sexuality implies that sexuality becomes equated with sexual activity, since functional neuroimaging tools primarily enable the study of people doing specific tasks. Here the main tasks consist most often in watching erotica or receiving stimulation, which researchers take as a proxy for the arousal the participants experience when in real-life sexual situations. But of course, these tasks (just like reeling the reel) are assumed to tell us the most essential thing we need to know about the non-experimental world of sexuality

(the biking in a bike race). There is nothing dishonest about this reduction. However, this reductionism suggests that all we need to know about outside-scanner sexuality is accurately portrayed by a few well-chosen, meaningfully and carefully idealized, tightly scripted, sexual acts. Sexuality is produced and modeled as brain-sexual activity independent of its own outside.

When described as a neural network, sexual arousal becomes described as a messy system of brain areas and, sometimes, different kinds of 'pathways'. The amygdala, the hypothalamus, and the thalamus are brain areas frequently emphasized in neuroscientific studies of sexuality. Dopamine and the dopaminergic system are recurrent figures of pathways in the publications about sexual pleasure.

These brain areas and pathways are in turn, the bearers of a certain psychological or emotional function, which, in the publications, is attributed to them on the basis of previous studies. For instance, proposing interpretations of the involvement of brain region VTA (ventral tegmental area) in orgasm, Holstege and colleagues write: 'VTA was also seen during cocaine [Breiter et al., 1997] and heroin rush [Sell et al., 1999] the VTA is the key element in both heroin and sexual orgasm ... anatomical substrate for the strongly reinforcing nature of sexual activity in humans' (Holstege et al 2003, 9183). Through reference to previ-

ous neuroscientific studies, brain areas and sex acquire here the addictive character of 'rush'.¹⁹

One general neural model of arousal used in many neuroimaging publications was proposed in the late 1990s (Redouté et al 2000; Stoléru et al 1999). It described the sexual response in the brain (in men) as made of four psychological/brain components: first, a cognitive component, by which situations could be identified as sexual and their 'incentive value' assessed; second, an emotional component, which reflected that it feels nice to be aroused (often, this component was proposed to reflect the pleasurable awareness of erection); third, a motivational component: expecting something pleasurable to happen; fourth, an 'autonomous' bodily component, erection happens. When interpreted through the lenses of neuroscience, sexuality thus becomes a set of classical neuroscientific functions (cognition, emotion, motivation).²⁰ To the neuroscience hammer, everything may well look like a cognition-motivation-emotion nail.

The neuroscientific braining of sexuality thus entails the attribution of specific psychological, emotional or behavioral functions to sex.

Differential Braining of Sexuality

Brained pleasure is no more universal than the cultural notions of sexuality that underpin it. In particular, the cerebralization of sexuality re-creates, in a messy manner, ver-

sions of a male and a female sexuality (although paradoxically subjecting both to the HSRC model which feminist sexologists have characterized as representative of a specific male sexual style).²¹

The differential attribution of qualities to male and female sexuality takes place through researchers' special focus on a few areas of the brain for which they find different activation patterns among men and women. Two striking points in this practice emerge:

First, the gender differences claimed as found are not consistent throughout the publications. They vary in what they are a difference of, for example, whether they concern sexological results (such as the degree of arousal reached in reaction to similar stimulation), or whether they concern the neural networks involved, and, in case of the latter, which areas of the brain make what difference. Some studies identify brain areas as central to sexual arousal whereas others do not find involvement at all of the same brain areas.²² The results also vary as to whether there is an overall difference between the neural networks of male and female sexuality. For instance, some studies claim that they have found a universal network of arousal which is the same in homo- and heterosexual men and women (e.g. Ponseti 2006).

Second, sex differences in neural networks of sexuality are a recurrent topic in the investigations.

The efforts to identify the role of the hypothalamus as a key structure of sexuality in general, and of male sexuality in particular, generates figures of female sexuality as elusive and difficult to explain. For instance, a recurrent observation of sexual difference seems to generate some confusion among neuroscientists. In male participants, subjective and objective arousal are often found to match well. In contrast, a divergence was recurrently observed between how sexually aroused female participants feel, on the one hand, and physiological measurements of their arousal, on the other. Using the male 'match' as a reference renders the sexual experiences of the female group unintelligible and makes women's sexuality an obscure thing as a whole. Two neuroscientists write: 'the average differences between the sexes were striking...It is unclear, therefore, which neural system mediates the sexual arousal reported by the women in this study [Hamann et al. 2004]' (Canli and Gabrieli 2004, 325–6).²³

In order to explain these brain-sexual differences between men and women found in a few studies, neuroscientists take to more elaborate arguments about the neuropsychological processes at work in sexual arousal. Karama and colleagues (2002) proposed a neural version of the interpretation that men's subjective arousal matches their objective arousal because erection makes men aware of their sexual excite-

ment. They explained this by reference to another structure of the brain, the thalamus. In this hypothetical model, the thalamus stands for a 'conscious awareness': The lesser activation of the thalamus could represent a lesser awareness of ongoing arousal and explain that women experienced less sexual arousal even when objectively aroused (Karama et al 2002, 9). In their model, the hypothalamus would make the connection in men between high arousal level, erection and felt arousal – but the hypothalamus is not activated in such a way in women, whose consciousness thereby is described, implicitly and again, as failing, for reasons unintelligible to scientists.

It is not surprising in itself that neuroimaging studies dedicate so much attention to the hypothalamus, since it has often been thought to be involved in reproduction and therefore in sexuality (cf. Dussauge and Kaiser 2012). The consideration that female sexuality is mysterious and complex is not surprising either, in the sense that it repeats a figure dear to nineteenth-century sexology (cf. Irvine 1990).

Rather, this illustrates that the stabilization of neural networks as systems of functions (not only as maps) generates difference. Since the qualitative relations of participants to erotic imagery or sexuality in general are erased, the only interpretative frame left for neuroscientists to make sense of possible

group differences is gender, which in turn comes to function as an implicit explanatory factor of sexuality (even if not causally so).

The amygdala is also salient in the neuroimaging studies of sexuality, just as it is a central but messy figure of the neurobiological imaginary of emotion. Nicole Karafyllis and Gotlind Ulshofer write:

In current emotions research of the neurosciences, the map of the human brain has a new earth at its center (no sun), around which many planets, metaphorically embodying scientific approaches, are orbiting: the amygdala. Particularly social (cognitive) neurosciences have been creating a new cosmic system around this small area of the brain, and the hope to one day finally understand 'it all': emotions, sexuality, behaviors, attitudes, relationships, social norms, personal success, and more – in short, the human and the society (in singular). However, this new anthropology which is now on the horizon is still working with classical stereotypes...Even if this sounds like an old story to feminists, the rhetorics and entities recently have changed: It is not women and men, or their bodies and their brains, but female brains and male brains. (Karafyllis and Ulshöfer 2008, 2).

Here in sexuality studies, the amygdala is attributed emotional

almost-agency with conveniently blurry functions such as ‘mediating’, and especially ‘mediating’ putative differences, as for instance, the figure of men’s purported greater interest in bodily appearance and visual erotica: ‘the human amygdala may also mediate the reportedly greater role of visual stimuli in male sexual behavior,’ (Hamann et al 2004). The elusive relation of ‘mediation’ between these salient brain structures and behavior is mobilized in changing directions. Sometimes sexuality is treated as a variable which mediates gender, i.e. which makes gay men similar to straight women as regards the structure of the amygdala. This, in turn, would explain gay men and heterosexual women’s greater emotional reactivity and their ‘higher vulnerability’ to stress, depression and suicide (Savic and Lindström 2008, 9407).

One caveat is that the amygdala and hypothalamus have been found to be involved in such a large range of human functions that the meanings neuroscientists attach to sexuality through the amygdala are extremely varied (for instance aggressivity and jealousy upon infidelity in men in Takahashi et al 2006).

The braining of emotions cannot be less differentiating than the notions of emotions, gender and sexuality mobilized in the process. The point is that the horde of possible functions attached to the hypothalamus, thalamus, and amygdala in previous neuroscientific literature

makes them convenient tools to make a long jump between patterns of brain activation (and differences in those), and emotions/behavior. This attribution of emotional/behavioral functions to parts of the brain network is a crucial site of the reproduction of tales of difference and likeness, now in allegedly neural terms.

Universal and Binarized

There is an apparent paradox between the way sexuality is studied as a universal human/neural phenomenon, on the one hand, and the insistence of categories male/female and homo/hetero, in the neural descriptions of sexuality.

The neuroimaging studies consider that sexual arousal unfolds following a linear response cycle, and that the brain is the seat of that unfolding in all healthy individuals. In that sense, neural sexual desire/pleasure is treated as a universal phenomenon. (Of course, this universal desire deployed in the experiments is dependent on the erasure of the specificities of lived sexual lives and lived sexual practices.)

However, the neuroimaging studies also often argue that there are differences between men and women, or between homo- and heterosexuals, at some of the following levels: brain structure, the patterns of neural activation, the sexological patterns (when people are turned on), and/or the physiological response of participants during the experiments.

For instance, some neuroscientific publications (Hamann et al 2004) propose that men and women differ in neural networks (structure/activation) and in sexological response (intensity of arousal), and that the two levels might be linked. Others propose universal brain models of desire independent of gender or sexual orientation (e.g. Kranz and Ishai 2006; Ponseti et al 2006), reducing the homo/hetero difference to an unexplained sexological difference: people are simply turned on by different genders.

The paradox between the implicit assumption of the existence of a universal sexual desire and that of the existence of binary categories of the person (women/men, homo/hetero) also rests on unresolved (or neglected) inconsistencies between publications. A few papers call for caution, especially in the interpretation of the relation between brain results and sexological results (Canli and Gabrieli 2004; Komisaruk and Whipple 2005).

Thus today's sexual neuroscience recapitulates two contradictory historical trends in sexology (Irvine 1990): on the one hand, the 1950s–1960s model of likeness between men and women, pursued by Kinsey and colleagues and later Masters and Johnson, and on the other hand, an insistence (both older and more contemporary) on the difference between men and women. This renewed insistence on difference seems to belong to

the conservative contributions to the highly political field of sexuality in a historical era which has seen both huge changes in sexual liberties (among others with feminist and LGBT movements) and a concomitant conservative counter-current promoting traditional gender roles and values (cf. Lancaster 2003).

Discussion: Neural Framing

What counts as 'the brain' matters at a number of levels for how sexuality can be defined, studied, and described. Borrowing again from Brown's work, we may say that just like the reel functioned as the right tool to talk about racing as social competition, if functional neuro-imaging is the right tool to talk about sexuality, it defines, in part, what sexuality can be.

I call this productive reduction the 'neuro-framing' of sexuality. With this term, I mean to acknowledge the transformative power of the neurosciences: neuroscientization of sexuality, gender and emotions affects the ways these are culturally conceived of (and, probably, how they can be lived).²⁴

This neuro-framing takes place throughout the production of neuroscientific facts: from participant selection and experiment design, through interpretation of data as meaningful differences (between conditions; between groups), and their becoming embedded in a brain geography of the human phenomenon under study.

When neurally framed, sexuality is idealized: as pure (ageless), perfectly oriented along the homo/hetero-axis, bodiless, distilled to an essence independent of its objects and feelers. In turn, sexuality is described as taking place in an individual subjective body, a placeholder, and sexual desire/pleasure arises more or less strongly in that body in interaction with triggers outside of it. In that sense, sexuality is re-embodied as the same universal in a multitude of individual but de-qualified placeholders.

The neuro-framing of sexuality operates both at a conceptual level and at a material level. The conceptual level entails the notions of sexuality, gender, behavior and the brain with which the experiments are designed and conducted, and with which the results are interpreted. On the material level, bodies and brains are recruited, instructed and made to perform sexual scripts which in turn build on implicit or explicit assumptions about sexuality, gender, behavior and the brain. Bodies (including brains) and their subjectivities are instrumentalized with regards to one goal: neuroscientific knowledge production (Burri 2007). Therefore neuro-framing effects a material-semiotic production of sexuality along reductionist lines.

Making sexuality neural with neuroimaging retains of sexuality only what is reflected/effected as statistically significant patterns of brain activity. In the existing configuration

of neuroscientific investigations, this means that all human activity which can be inferred to occur outside of a certain version of well-directed sexual and cognitive situations is obliterated. The possibility of the erotic outside of the pornographically or contact-wise triggered sexual is erased; as is the possibility of the erotic as something other than responsive brain/sexual activity.

Neuro-framing does the same job for the notions of desire and pleasure as the HSRCM has done for sex: it contributes to their de-contextualization, physiologization, de-politicization, and focus on a linear physiological performance or activity. At the same time, in a paradoxical gesture, sexuality is de-corporealized as the crucial site of its existence. Lived experience and agency are displaced from the body to the brain. Not only does this de-corporealization erase its prior de-politicization – it also opens for the fantasy of re-describing sexual agency in neural terms.

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Endnotes

- ¹ In the present study, 'functional neuroimaging' refers to PET, fMRI and SPECT.
- ² Search conducted on the online databases for medicine and psychology MEDLINE and PsycInfo.
- ³ A smaller group of studies addresses the neurobiology of love and 'attractiveness' but for the sake of clarity I do not attend to these two themes here.
- ⁴ Two-thirds of the published experiments feature men, and one-third feature women. About two-thirds of the papers feature heterosexuals; less than twenty percent feature homosexuals; and less than twenty percent work with participants of unspecified sexual orientation (who we can fairly assume are presumed heterosexuals).
- ⁵ One published experiment working with sado-masochism about pleasure and disgust features explicitly bisexual participants (see Stark et al 2005). One study (Arnou et al 2002) excluded volunteers who had no experience of sexual intercourse.
- ⁶ For instance, several studies (e.g. Karama et al 2002; Miyagawa, Tsujimura et al 2007; Walter et al 2008) do not report how the sexual preference of the subjects was identified, and several studies (e.g. Rauch et al 1999; Beauregard et al 2001; Park et al 2001; Childress et al 2008; Roberts et al 2008) do not specify the sexual orientation of the participants at all. In contrast, many studies (e.g. Bocher, Chisin et al 2001; Stark, Schienle et al 2005; Brunetti, Babiloni et al 2008) used self-definition as assessment of sexual orientation, and most studies report the use of standardized questionnaires.
- ⁷ This was the case in Berglund et al (2006); Ponseti et al (2006); Paul et al (2008); Savic and Lindström (2008), although in Berglund et al (2006) and Savic & Lindström (2008), the heterosexuals scored 0.
- ⁸ This notion that sexuality is describable as a set of distinct sexual preferences (homo, hetero, and bi as something in between) defined by a sexually preferred gender echoes some of the misinterpretations of the Kinsey scale within sexology and the history of sexuality described by historian Donna Drucker (2010). Kinsey's intention in proposing the 0–6 scale in 1948 was, Drucker explains, to 'eradicate sexual identity categories' by proposing a model of sexual behavior as not only diverse between individuals, but individually changing along a person's lifetime. In that sense, the 1–5 parts of the scale refer to different places in sexual life, so to speak, and not to a combination of homo- and heterosexuality.
- ⁹ The extent to which sexual desire and pleasure are being studied as a universal phenomenon is fascinating indeed. In particular, one study went to great length to select pornographic materials that men and women find equally arousing (Hamann et al 2004). But why do this, if women and men sociologically (and statistically) differ in their relation to porn and in how arousing they find mainstream erotica? Of course, this is because the participants' qualitative lived relation to erotica does not matter to the experiment design. What turns people on and why is not the object of neuroimaging study. What is under investigation, rather, is the possible difference in patterns of brain activity when people or groups are turned on to a similar extent.
- ¹⁰ A most flagrant example is the experiment by Paul et al (2008) who had the partici-

pants view two kinds of erotic videos: homosexual and heterosexual erotica, respectively. The two experimental conditions were called 'corresponding' and 'opposite', referring to the participant's own preferred sexual activity. This is not the only way to organize a sexual experiment: for instance, Safron et al (2007) design their experiment and choice of stimuli around the alternative assumption that men's arousal is 'category-specific', i.e. that men are turned on primarily by watching at least one person of the gender they themselves have a sexual preference for engage in sexual activity.

¹¹ For a commentary about the feminist criticism of the HSRM, see Pernrud (2007).

¹² Cf. Karafyllis and Ulshöfer's short but similar comment about 'sexual elites' in brain research (2008, 21).

¹³ Explicit examples of this are Miyagawa et al (2007) and Hamann et al (2004).

¹⁴ Cf. also Karafyllis and Ulshöfer's observation (2008, 21).

¹⁵ About specificity's special epistemological value in the life sciences, see Lee (2011) and Mulinari (2011).

¹⁶ I.e. the 'sexual' in 'getting sexually aroused by watching erotic pictures'. This follows from the logic of subtraction of the brain data for watching bodily interactions from sexual arousal brain data.

¹⁷ About epistemological 'cleaning up', see Cartwright (1997/1995, 90; 81–106), Amman and Knorr Cetina (1990) and Dussauge (2008, 175–179; 86).

¹⁸ A cultural trope is that the neuroimaging scanner can yield the answer to such questions, and identify what kinds of feelings are going on inside the participants' brains. However, we realize here that the logic of identifying arousal works the other way around: neuroscientists need to know whether subjects are aroused or not or how much precisely in order to statistically extract the brain data which in turn yields 'sexual arousal'. Such epistemological strategies reveal a distinct epistemological anxiety 'of the first per-

son' which is pivotal to all neuroimaging experiments: how do you know whether participants are aroused, or what that arousal is like? About challenges and serious attempts of first-person perspectives in neuroscience and cognitive sciences, see Jack and Roepstorff (2003).

¹⁹ I address elsewhere more thoroughly the shaping of sexuality through references to neuroeconomics and the neuroscience of addiction ('Sex, Cash and Neuromodels of Desire', submitted to *BioSocieties*).

²⁰ Cf. Aud Sissel Hoel, conversation 21 December 2011.

²¹ The insistence on gender differences along competing claims of gender similarities within the same neuroscientific field recapitulates trends of emphasizing difference or likeness in the history of sexology, see e.g. Irvine (1990).

²² For instance, Karama et al (2002) suggested gender-different activations of the thalamus and hypothalamus, whereas Hamann et al (2004) found gender-related differences in amygdala activation (which Karama and colleagues did not find). Walter et al (2008) found involvement of these regions in sexual arousal but no gender differences in the activation of these regions nor in reported arousal. Note that Moulier and colleagues (2006) suggested that problematic inconsistencies of this kind exist – and are problematic – in the whole field of neuroimaging studies of sexuality.

²³ On the same topic, see Downey (2009).

²⁴ Karafyllis and Ulshöfer acknowledge this transformative power of the neurosciences: 'in recent years, models and terms (from the field of neurosciences and cognitive sciences have colonized the epistemic cultures (Knorr-Cetina 1999) of many other disciplines, in the process transforming some of their ideas about what is normal, what is human, and, not

least, what determines a functioning society' (Karafyllis and Ulshöfer 2008, 5).

Bibliography

- Ahmed, S. 2006. *Queer Phenomenology*. Durham: Duke University Press.
- Amman, K. and K. Cetina. 1990. The Fixation of (Visual) Evidence. In Representation. In eds. M. Lynch and S. Woolgar. *Scientific Practice*. Cambridge: MIT Press.
- Arnou, B., J. Desmond, L. Banner, G. Glover, A. Solomon, M. Polan, T. Lue, and S. Atlas. 2002. Brain Activation and Sexual Arousal in Healthy, Heterosexual Males. *Brain*, 125 (5):1014–23.
- Beaulieu, A. 2000. *The Space Inside the Skull: Digital Representations, Brain Mapping and Cognitive Neuroscience in the Decade of the Brain*. Ph.D. Dissertation. Amsterdam: University of Amsterdam.
- Beauregard, M., J. Levesque, and P. Bourgouin. 2001. Neural Correlates of Conscious Self-Regulation of Emotion. *The Journal of Neuroscience* 21 (18): RC165.
- Berglund, H., P. Lindström and I. Savic. 2006. Brain Response to Putative Pheromones in Lesbian Women. *Proceedings of the National Academy of Sciences USA* 103 (21): 8269–74.
- Bocher, M., R. Chisin, Y. Parag, N. Freedman, Y. Meir Weil, H. Lester, E. Mishani, and O. Bonne. 2001. Cerebral Activation Associated with Sexual Arousal in Response to a Pornographic Clip: A 15O-H₂O PET Study in Heterosexual Men. *NeuroImage* 14 (1): 105–17.
- Brown, S. D. 2012. Abstract Experimentalism. Available at http://www.academia.edu/716478/Abstract_Experimentalism [Accessed online 6 February 2013].
- Brunetti, M., C. Babiloni, A. Ferretti, C. Del Gratta, A. Merla, M. Olivetti Belardinelli, and L.G. Romani. 2008. Hypothalamus, Sexual Arousal and Psychosexual Identity in Human Males: A Functional Magnetic Resonance Imaging Study. *European Journal of Neuroscience* 27 (11): 2922–7.
- Burri, R. V. 2007. Sociotechnical Anatomy: Technology, Space and Body in the MRI Unit. In ed. R. V. Burri and J. Dumit. *Biomedicine as Culture: Instrumental Practices, Technoscientific Knowledge, and New Modes of Life*. New York; Oxon: Routledge.
- Canli, T. and J. Gabrieli. 2004. Imaging Gender Differences in Sexual Arousal. *Nature Neuroscience* 7 (4): 325–6.
- Cartwright, L. 1997/1995. *Screening The Body: Tracing Medicine's Visual Culture*. Minneapolis; London: University of Minnesota Press.
- Childress, A. R., R. N. Ehrman, Z. Wang, Y. Li, N. Sciortino, J. Hakun, W. Jens, J. Suh, J. Listerud, K. Marquez, T. Franklin, D. Langleben, J. Detre, and C.P. O'Brien. 2008. Prelude to Passion: Limbic Activation by 'Unseen' Drug and Sexual Cues. *PLOS ONE* 3 (1): e1506.
- Cohn, S. 2008. Petty Cash and the Neuroscientific Mapping of Pleasure. *BioSocieties* 3 (02): 151–63.
- Cohn, S. 2011. Visualizing Disgust: Subtractions and Assimilations in the Production of Neuroscientific Knowledge. In eds. F. Ortega and F. Vidal. *Neurocultures: Glimpses*

- es Into an Expanding Universe*. Frankfurt am Main: Peter Lang: 181–98.
- Dennis, C. 2004. The Most Important Sexual Organ. *Nature* 427: 390–2.
- Downey, G. 2009. What Do These Enigmatic Women Want? In *Neuroanthropology*. Available at <http://www.neuroanthropology.net> [Accessed 25 January 2009].
- Drucker, D. 2010. Male Sexuality and Alfred Kinsey's 0–6 Scale: Toward A Sound Understanding of the 'Realities of Sex'. *Journal of Homosexuality* 57 (9): 1105–23.
- Dumit, J. 2004. *Picturing Personhood: Brain Scans and Biomedical Identity*. Princeton, N.J.: Princeton University Press.
- Dussauge, I. 2008. *Technomedical Visions: Magnetic Resonance Imaging in 1980s Sweden*. Ph.D. Dissertation. Stockholm: KTH Filosofi och teknikhistoria.
- Dussauge, I. and A. Kaiser. 2012. Re-Queering the Brain. In eds. R. Bluhm, A.J. Jacobson and H. Mailbom. *Neurofeminism: Issues at the Intersection of Feminist Theory and Cognitive Neuroscience*. Houndmills, Basingstoke, Hampshire: Palgrave Macmillan: 121–44.
- Espeland, W. and M. Stevens. 1998. Commensuration as a Social Process. *Annual Review of Sociology* 24: 313–43.
- Ferretti, A., M. Caulo, C. Del Gratta, R. Di Matteo, A. Merla, F. Montorsi, V. Pizzella, P. Pompa, P. Rigatti, P. Rossini, A. Salonia, A. Tartaro, and G. Romani. 2005. Dynamics of Male Sexual Arousal: Distinct Components of Brain Activation Revealed by fMRI. *NeuroImage* 26 (4): 1086–96.
- Garnett, E.S., C. Nahmias, G. Wortzman, R. Langevin, and R. Dickey. 1988. Positron Emission Tomography and Sexual Arousal in a Sadist and Two Controls. *Sexual Abuse: A Journal of Research and Treatment* 1 (3): 387–99.
- Georgiadis, J., R. Kortekaas, R. Kuipers, A. Nieuwenburg, J. Pruijm, A. A. T. Simone Reinders, and G. Holstege. 2006. Regional Cerebral Blood Flow Changes Associated With Clitorally Induced Orgasm in Healthy Women. *European Journal of Neuroscience* 24 (11): 3305–16.
- Hamann, S., R. Herman, C. Nolan, and K. Wallen. 2004. Men And Women Differ In Amygdala Response To Visual Sexual Stimuli. *Nature Neuroscience* 7 (4): 411–6.
- Holstege, G., J.R. Georgiadis, A.M. Paans, L.C. Meiners, F.H. van der Graaf, and A.A. Reinders. 2003. Brain Activation During Human Male Ejaculation. *The Journal of Neuroscience* 23 (27): 9185–93.
- Irvine, J. 1990. From Difference to Sameness: Gender Ideology in Sexual Science. *The Journal of Sex Research* 27 (1): 7–24.
- Jack, A. and A. Roepstorff, eds. 2003. *Trusting the Subject? The Use of Introspective Evidence in Cognitive Science*. Thorverton: Imprint Academic.
- Karafyllis, N. and G. Ulshöfer. 2008. *Sexualized Brains: Scientific Modeling of Emotional Intelligence from a Cultural Perspective*. Cambridge, MA: MIT Press.
- Karama, S., A. Lecours, J. Leroux, P. Bourgouin, G. Beaudoin, S. Joubert and M. Beauregard. 2002.

- Areas of Brain Activation in Males and Females During Viewing Of Erotic Film Excerpts. *Human Brain Mapping* 16 (1): 1–13.
- Kinsey, A., W. B. Pomeroy and C.E. Martin. *Sexual Behavior In The Human Male*. Philadelphia: Saunders.
- Kosofsky Sedgwick, E. 1990. *Epistemology Of The Closet*. Berkeley: University of California Press.
- Komisaruk, B. and B. Whipple. 2005. Functional MRI Of The Brain During Orgasm In Women. *Annual Review of Sex Research* 16: 62–86.
- Komisaruk, B., B. Whipple, A. Crawford, S. Grimes, W. Liu, A. Kalnin, and K. Mosier. 2004. Brain Activation During Vaginal Self-Stimulation And Orgasm In Women With Complete Spinal Cord Injury: fMRI Evidence Of Mediation By The Vagus Nerves. *Brain Research* 1024 (1–2): 77–88.
- Lee, F. 2011. Hit by a Bandwagon and Saved by Magicians: On the Moral Economy of Proteomics. Paper presented at the workshop *The Moral Economy of Life Science*, Vadstena.
- LeVay, S. 1991. A Difference In Hypothalamic Structure Between Heterosexual And Homosexual Men. *Science* 253 (5023): 1034–7.
- Martensen, R., 2004. *The Brain Takes Shape: An early history*. Oxford, New York: Oxford University Press.
- Martin, E. 2010. Self-Making And The Brain. *Subjectivities* 3 (4): 366–81.
- Masters, W., and V. Johnson. 1966. *Human Sexual Response*. Boston: Little, Brown and Co.
- Miyagawa, Y., A. Tsujimura, K. Fujita, Y. Matsuoka, T. Takahashi, T. Takao, S. Takada, K. Matsumiya, Y. Osaki, M. Takasawa, N. Oku, J. Hatazawa, S. Kaneko and A. Okuyama. 2007. Differential Brain Processing Of Audiovisual Sexual Stimuli in Men: Comparative Positron Emission Tomography Study of the Initiation and Maintenance of Penile Erection During Sexual Arousal. *NeuroImage* 36 (3): 830–42.
- Moulier, V., H. Mouras, M. Pelegrini-Issac, D. Glutron, R. Rouxel, B. Grandjean, J. Bittoun and S. Stoléru, 2006. Neuroanatomical Correlates of Penile Erection Evoked By Photographic Stimuli in Human Males. *NeuroImage* 33: 689–99.
- Mouras, H., S. Stoléru, J. Bittoun, D. Glutron, M. Pélégini-Issac, A. Paradis and Y. Burnod. 2003. Brain Processing of Visual Sexual Stimuli in Healthy Men: A Functional Magnetic Resonance Imaging Study. *NeuroImage* 20 (2): 855–69.
- Mulinari, S. 2011. The Specificity Triad and the Style of Thought of Biomedicine. Paper presented at the workshop *Broar och brott mellan biologi och det sociala – nya utmaningar och empiriska nedslag med fokus på kropp och medicin*, Ystad.
- Park, K., H. Kang, J. Seo, H. Kim, S. Ryu, and G. Jeong. 2001. Blood-Oxygenation-Level-Dependent Functional Magnetic Resonance Imaging For Evaluating Cerebral Regions Of Female Sexual Arousal Response. *Urology* 57 (6): 1189–94.
- Paul, T., B. Schiffer, T. Zwarg, T. Krüger,

- S. Karama, M. Schedlowski, M. Forsting, and E. Gizewski. 2008. Brain Response to Visual Sexual Stimuli in Heterosexual and Homosexual Males. *Human Brain Mapping* 29 (6): 726–35.
- Pernrud, B. 2007. Diffracting Feminist Sex Therapy. *Graduate Journal of Social Science* 4 (2): a05.
- Ponseti, J., H. Bosinski, S. Wolff, M. Peller, O. Jansen, H. Mehdorn, C. Büchel and H. Siebner. 2006. A Functional Endophenotype for Sexual Orientation in Humans. *NeuroImage* 33 (3): 825–33.
- Ponseti, J., O. Granert, O. Jansen, S. Wolff, H. Mehdorn, H. Bosinski and H. Siebner. 2009. Assessment of Sexual Orientation Using the Hemodynamic Brain Response to Visual Sexual Stimuli. *Journal of Sexual Medicine* 6 (6): 1628–34.
- Rauch, S., L. Shin, D. Dougherty, N. Alpert, S. Orr, M. Lasko, M. Macklin, A. Fischman and R. Pitman. 1999. Neural Activation During Sexual and Competitive Arousal in Healthy Men. *Psychiatry Research: Neuroimaging* 91 (1): 1–10.
- Redouté, J., S. Stoléru, M. Grégoire, N. Costes, L. Cinotti, F. Lavenne, D. Le Bars, M.G. Forest and J. Pujol. 2000. Brain Processing of Visual Sexual Stimuli in Human Males. *Human Brain Mapping* 11 (3): 162–77.
- Roberts, G. M., F. Newell, C. Simoes-Franklin and H. Garavan. 2008. Menstrual Cycle Phase Modulates Cognitive Control Over Male But Not Female Stimuli. *Brain Research*, 1224: 79–87.
- Rose, N. 2007. *The Politics Of Life Itself: Biomedicine, Power, And Subjectivity In The Twenty-First Century*. Princeton: Princeton University Press.
- Safron, A., B. Barch, J. Bailey, D. Gitelman, T. Parrish and P. Reber. 2007. Neural Correlates of Sexual Arousal in Homosexual and Heterosexual Men. *Behavioral Neuroscience* 121 (2): 237–48.
- Savic, I., and P. Lindström. 2008. PET and MRI Show Differences in Cerebral Asymmetry and Functional Connectivity Between Homo- And Heterosexual Subjects. *Proceedings of the National Academy of Sciences USA* 105 (27): 9403–8.
- Stark, R., A. Schienle, C. Girod, B. Walter, P. Kirsch, C. Blecker, U. Ott, A. Schäfer, G. Sammer, M. Zimmermann and D. Vaitl. 2005. Erotic and Disgust-Inducing Pictures – Differences in the Hemodynamic Responses of the Brain. *Biological Psychology* 70 (1): 19–29.
- Stein, E. 1999. *The Mismeasure of Desire: The Science, Theory, and Ethics of Sexual Orientation*. Oxford: Oxford University Press.
- Stoléru, S., M. Gregoire, D. Gerard, J. Decety, E. Lafarge, L. Cinotti, F. Lavenne, D. Le Bars, E. Vernet-Maury, H. Rada, C. Collet, B. Mazoyer, M. Forest, F. Magnin, A. Spira and D. Comar. 1999. Neuroanatomical Correlates of Visually Evoked Sexual Arousal in Human Males. *Archives of Sexual Behavior* 28 (1): 1–21.
- Swaab, D., L. Gooren and M. Hofman. 1992. Gender and Sexual Orientation in Relation To Hypothalamic Structures. *Hormone Research* 38 (Suppl 2): 51–61.
- Takahashi, H., M. Matsuura, N. Yahata, M. Koeda, T. Sahara, and

- Y. Okubo. 2006. Men and Women Show Distinct Brain Activations During Imagery of Sexual and Emotional Infidelity. *NeuroImage* 32 (3): 1299–307.
- Tiefer, L. 2002. Arriving at a ‘New View’ of Women’s Sexual Problems. *Women & Therapy* 24 (1–2): 63–98.
- Vidal, F. 2009. Brainhood, Anthropological Figure of Modernity. *History of the Human Sciences* 22 (1): 5–36.
- Vidal, F., and F. Ortega. 2011. Approaching the Neurocultural Spectrum: An Introduction. In eds. F. Ortega and F. Vidal. *Neurocultures: Glimpses into an Expanding Universe*. Frankfurt am Main: Peter Lang.
- Walter, M., F. BERPPOHL, H. MOURAS, K. SCHILTZ, C. TEMPELMANN, M. ROTTE, H.J. HEINZE, B. BOGERTS, and G. NORTHOFF. 2008. Distinguishing Specific Sexual and General Emotional Effects in fMRI-subcortical and Cortical Arousal During Erotic Picture Viewing. *NeuroImage* 40 (4): 1482–94.