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NEVER MIND THE GAP!

Gendering Science in Transgressive Encounters

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EDITED BY MARTHA BLOMQVIST & ESTER EHNSMYR

Centre for Gender Research

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Editors' Foreword

One of the commissions of Centre for Gender Research at Uppsala University is to include social as well as biological perspectives on gender in its research. Bringing in both perspectives may seem a reasonable assignment. However, the mission was also, when issued in 2003, understood as quite controversial, and critical voices were heard referring to biologism and a backlash in gender research. Given that the relationship between gender research and the natural sciences has been somewhat strained over the years, this did not come as a surprise.

With a view to exploring the possibilities of exchange with researchers in the natural sciences, the Centre, during the first years, organized seminars and sought partners in the natural sciences who were interested in cooperation with gender researchers in the humanities and social sciences already connected to the Centre. When the Swedish Research Council in 2007 made the Centre a Centre of Gender Excellence and funded the research programme *GenNa: Nature/Culture and Transgressive Encounters*, our interdisciplinary work engaging cultural, social and natural scientists in the critical and important focus on gender and science could be intensified.

Divides between gender research and the natural sciences have caused a number of intense disputes over the years. Debates about genetic vs. environmental influence on, e.g., body and health are recurrent. As regards sex/gender, the related question concerns biol-

ogy vs. social construction. Theoretical developments in feminism during recent decades have generally expanded the gender territory, by enhancing the claims about aspects of body and behaviour being socially constructed, consequently challenging aspects that used to be understood as biology and hence more stable. During the same time period, the natural sciences have been able, with the help of refined technology, to scrutinize previously hidden and unknown processes in the human brain and the genome. As a result, more and more aspects of human functions, capacities and behaviour are claimed to be based on biology. These independent theoretical achievements in feminism and the natural sciences are in many respects seemingly contradictory, and by the time of the turn of the millennium, it became obvious that research results from the two sides clashed now and then. Some of the past years' heated debates between feminists and natural scientists can be understood in the light of these developments.

We would like to engage in an open conversation over the borders of natural, social and cultural sciences. To this purpose, we believe the gender concept is an excellent boundary object. Being a core concept in gender science, on the one hand, and a concept that some natural scientists are challenging, on the other, it may be used as a point of departure for exciting discussions and examinations. Instead of trivializing and downplaying the differences between cultural and natural sciences, we think the gaps and contradictions may be used for transgressive encounters and critical insights. Thus, it is not as if we have not noticed that there is a gap, or perhaps many gaps. We have, but as the title of the publication suggests, they are not definite and unchallengeable, and investigating them may be very productive.

The authors of this publication stand for quite different scien-

tific approaches to the field of nature/culture, and they approach the gap(s) in different ways. Still they have a great deal in common. First, they share the objective of exploring issues at the border of the traditional disciplines. Second, they are all convinced that there is something to gain from talking and communicating across the borders of natural and cultural sciences. Third, they are committed to the development of new common grounds for transgressive encounters between different scientific traditions.

The publication consists of nine chapters, all written by researchers connected to the Centre for Gender Research at Uppsala University, and all interested in theoretically and empirically approaching the nature/culture divide. Making use of their specific knowledge, the researchers delineate how gender-relevant issues are discussed and problematized in their field of knowledge, what the controversies and debates have been about historically, what they are about today, and they inform us about empirical findings, central concepts and theories. Our GenNa programme has hosted several internationally renowned researchers over the years. We are very happy that many of them wanted to contribute to this publication.

Taken together, the chapters give an informed and up-to-date overview of a new generation of feminist science studies, encountering the nature/culture research field, they illuminate the great variety of approaches in studies conducted in the field, they point at recent advances and present challenges and possibilities, and they provide ample references to anyone interested in further reading. This publication should therefore be of interest not only to researchers already involved in the research areas presented here, but to anyone who wishes to keep an eye on recent developments in these fields of research trying to transgress bounda-

ries between nature and culture and to develop a better understanding of gender aspects in the natural sciences. We hope that the book will challenge at least some of the readers' assumptions about 'other' disciplines as well as their own. We also look forward to feedback on the contents of the anthology, and we hope it will generate further discussions on the nature/culture divide in science, when trying to understand gendered issues.

Martha Blomqvist & Ester Ehnsmyr

Uppsala March, 2010

Notes on the contributors

MALIN AH-KING is an evolutionary biologist and was a researcher in gender and animal studies at the Centre for Gender Research at Uppsala University, 2007–2009. Her research aims at problematizing the portrayal of biological sex as stable, making visible stereotypic gender and heteronormative notions in theory and research as well as developing non-normative models of variation in nature's sexes and sexualities. She is now a post-doc at UCLA with a project that is a natural development in this line of research, namely to test hypotheses about selective forces behind the diversity in sex determination systems.

STAFFAN BERGWIK has a PhD in History of Science and works as an assistant professor at the Centre for Gender Research at Uppsala University. His current research project is entitled "On the Outskirts of Science: Women as outsiders within Swedish science in the early 20th century". In his work, Bergwik combines the history of science with science and technology studies and feminist science studies to investigate the networks and power structures of academic science. Furthermore, he studies how women – working as unpaid researchers, assistants or family members – were partly part of science but also blocked from it. His work explores the history of peripheral, gendered positions as well as fractured scientific identities.

ANNA DANIELSSON, PhD in physics, works as a researcher at the Centre for Gender Research and at the Department of Physics and Materials Science, Uppsala University. Her research interests are centred on gender perspectives on physics education research. In her PhD thesis, entitled "Doing Physics – Doing Gender", she explores how university physics students in the context of laboratory work can be understood as simultaneously "doing physics" and "doing gender".

REBEKAH FOX is a cultural geographer and former guest researcher at the Centre for Gender Research, Uppsala University. Her work focuses upon human-animal relations, particularly in regard to companion animals, and she is currently working on a project entitled *Animals, Gender and Science: The World of Pedigree Pet Breeding and Showing*. This examines the intersections of gender, identity, species, genetics and power and challenges understandings of non-human agency within social theory, calling for a recognition of the 'social as more than human'.

HELENE GÖTSCHEL, PhD, studied physics; history of mathematics, science, and technology; social history and history of economy; and higher education at Universities in Tübingen and Hamburg, Germany. Since August 2007, she is a temporary researcher at the Centre for Gender Research at Uppsala University, working on "Visual Imagery and Invisible Gender in Electricity". Furthermore, in winter 2007, she was guest professor for "Gender & Science" at the Faculty of Chemistry, Technical University in Kaiserslautern, Germany, and in winter 2008, she was guest professor for "Gender & Physics" at the Center for Interdisciplinary Research on

Women and Gender, Carl von Ossietzky University, Oldenburg, Germany. In her habilitation research, Helene studies "Technology and Gender in Manufactories in Houses of Correction in 18th century Europe". Currently, she is editing an anthology on gender and material studies.

TORA HOLMBERG PhD in Sociology, works as a researcher at the Centre for Gender Research, Uppsala University, in the intersection of STS (Science and Technology Studies), animal studies and feminist science studies. In a recent, joint project entitled Dilemmas with transgenic animals, Tora Holmberg and Malin Ideland explore how the production of and research on transgenic animals are managed and authorized by actors involved in research and animal ethics committees. Since 2007, she also works as an academic coordinator for GenNa: Nature/Culture and Transgressive Encounters. This research programme aims at bringing together, under the umbrella of gender and science, scholars and perspectives from the social sciences, humanities and the natural sciences.

ANNA T. HÖGLUND is Associate Professor in Ethics and Senior Lecturer in Nursing Ethics and Gender Theory at the Department of Public Health and Caring Sciences at Uppsala University. She has published extensively on questions of gender and ethics, for example concerning violence against women and justice in relation to priority-setting in health care. Her research also covers questions of professional ethics and ethical competence for health care personnel. She is the author of three books, *War and Gender – Feminist Ethics and the Moral Judgement of Military Violence* (2001) and *No Easy Choices – On Guidelines and Ethical Competence in Priority-*

Setting in Health Care (2005), both written in Swedish with an English summary; and Gender on the War on Terrorism – The Justification of War in a Post – 9/11 Perspective (2010).

ANELIS KAISER works as a researcher at the Center for Gender Studies, University Basel, Switzerland. Prior to this, she investigated the question of multilingualism in the brain and completed her PhD in Psychology at the same university. The topic of her dissertation was gender similarities and gender differences in the brain detected with fMRI. To better understand the social aspects of neuroscience, she spent a year as visiting researcher at BIOS, LSE. Recently and together with Isabelle Dussauge, she has been working on an elaboration of the concept of a queer brain. Her interdisciplinary interests extend from science studies to gender studies and neuroscience.

ELVIRA SCHEICH, physicist and social scientist, came from the Technical University of Berlin as a guest professor to the GenNa programme at the Centre for Gender Research at Uppsala University. In her research, she combines gender studies, science studies and social theory. One of her long-standing research interests is in the notions of nature and materiality in feminist theory and feminist politics, with particular attention to the cultural multiplicity of the social relations with nature. As a second focus in her work, she investigates gender relations in physics and the gendering of physical knowledge.

TORA HOLMBERG | Never mind the gap? Genetics and feminism

> Genes have had a glorious run in the twentieth century, and they have inspired incomparable and astonishing advances in our understanding of living systems. Indeed, they have carried us to the edge of a new era in biology, one that holds out the promise of even more astonishing advances. But these new advances will necessitate the introduction of other concepts, other terms, and other ways of thinking about biological organization, thereby inevitably loosening the grip that genes have had on the imagination of life scientists these many decades. My hope is that such new concepts and new ways of thinking will soon work to loosen the even more powerful grip that genes have recently come to have on the popular imagination. (Evelyn Fox Keller 2000: 147–148)

Introduction

If you search the Web for "gender and genetics", you find articles on the genetic basis of gender identity, sex determination and the genetics and gender of the brain. This flags a connection between the concepts of gender and genes that is more than etymological (see also Åsberg 2005). But, contrary to this first impression, gender and feminist research and genetics have not, to say the least, been comfortable with each other. From a feminist perspective, this is mainly because arguments for a biological and unconditional base

of women's subordination have found legitimacy in genetics. Ever since the field was founded in the early 20th century, geneticists have tried to locate the differences, long searched for by biologists, between humans and other animals as well as among humans, including race and sex differences. Moreover, genetics, along with science in general, has reproduced the male norm: humans equal men. Thus, the feminist critique of the male norm and the claim to widen the category of "human" to also include women have led feminist science studies scholars to critically examine science in general and genetics in particular. In fact, the introduction of the concept "gender" was based on the wish to be able to hold apart the biological body ("sex") – including genes, hormones, and anatomy – from the societal power relations that produce women's subordination, thus enabling feminists to critically scrutinize the ways in which gender influences how science produces knowledge of sex (Keller and Longino 1996).

For more than three decades, feminist science studies scholars from a range of disciplines have developed insights through thorough critical analyses of genetics, from Hillary Rose's groundbreaking critique of socio-biology, through the work of Ruth Hubbard, Evelyn Fox Keller, Donna Haraway and Sarah Franklin. The analyses have been performed with analytical strength and have rendered results in terms of the ways they has changed science, for example when it comes to medical and reproductive genetics (see Schiebinger 2001). The focus of the studies has shifted over the years, roughly from critiquing the male bias, to engaging more with science itself. In this brief overview, which is by no means comprehensive, I will start off with a historical background of the biological question in feminism, continue with some of the more recent work done on genetics within the feminist science studies

tradition, and towards the end, I will discuss these examples together with the contributions in this volume.

It has been said that, during late modernity, the gene has received the status of a "cultural icon" (Nelkin & Lindee 1995). But, as Evelyn Fox Keller points out in the quote above from her book *The Century of the Gene* (2000), genetics has gone through some tremendous changes, which has led to a radical, almost paradigmatic change in the whole understanding of biological organization, including the role of the gene. Keller states that she hopes for a reconceptualization and a de-enchantment of the way scientists as well as lay people understand the "gene". The changing cultural landscape that represents the gene, called the genetic imaginery, has been analysed within feminist cultural science studies. Focusing on representations of the natural regarding, for example, sex and race, feminist science studies scholars have analysed narratives about the cloned sheep Dolly (Franklin 2007), the transgenic oncomouse (Haraway 1997) and the genetically engineered "fatherless" mouse Kaguya (Dahl 2004; Åsberg 2005). There are many connections made between genes and gender in this imaginary, in which taken-for-granted notions of sex, kinship, genealogy, reproduction and sexuality are called into question. In line with this, I search for other scholars who have followed this shift, and are now presenting new approaches – with a critical touch – towards and with genetics.

My epistemological position is informed by the work I have done in the field, and the engagements made. I am a sociologist with a STS (Science and Technology Studies) and feminist science studies perspective, who has done all my scholarly work on the nature/culture border. I have done so by investigating representations of behaviour genetics (twin- and animal-based research) in

science and media (2005a), practices and discourses on transgenic animals (Holmberg & Ideland 2009, Holmberg 2010), debates between biologists and gender scholars (2005b) and biological bodies within feminist and gender research (2008, Holmberg & Palm 2009). My reading of the texts, as well as how I represent them, stem from this research experience.

Sex(ual) difference

The sex/gender distinction, however productive, has since the late 1980s given rise to serious critique from within the feminist research collective. In Swedish, this distinction was first referred to as biological vs. social sex. As is well known, feminist approaches to "the biological question" have taken two somewhat different routes from the 70s onwards.[1] Early on, feminist theory, such as standpoint feminism, reclaimed the body from scientific discourse and stated the privileged role of everyday knowledge of women when it came to bodily matters (Hartsock 1983; Oakley 1972 & 1984). Scientific biological knowledge about women became problematic in the perspective of these movements, due to the fact that biological facts historically had been used in order to prove the validity of women's subordination. Paying close attention to the power asymmetry between knowledge produced by the scientific community, on the one hand, and women's own experience, on the other, the intimate connections between biology as a supposedly neutral science and the patriarchal oppression of women were highlighted (Birke 1999; see Hubbard 1979; Keller & Longino 1996). As mentioned above, a tool to produce sharp feminist critique of science, the sex/gender distinction, was embraced. By carving out gender as an analytical concept, feminist science stud-

1 Parts of this section are copied from Holmberg & Palm 2009.

ies scholars where enabled to see how the knowledge production of sex was influenced by notions of gender and sexism (Keller & Longino 1996).

This critique of biology as part of a patriarchal science was radicalized in the 80s into a more general critique of essentialism. The movement – with its postmodern, historicist, and social constructionist influences – levelled its critique of essentialism not only at biology, but, more importantly, turned at the early feminist enterprise in itself and its reliance on, for example, the category of "women" (hooks 1982; Butler 1990). Judith Butler also seriously questioned the distinction between biological sex and social gender, and would come to say that biological sex is also characterized by contingent, situated and socially accepted differences and, thereby, can be seen as yet another construction (1990). In later work, Butler deepened her analysis of the material body, saying that societal norms and discourses at once make biological bodies comprehensible and produce or *materialize* them (Butler 1993). In parallel with this broadening of "culture," a concept of gender – *genus* – was developed in Sweden that took the perspective of the societal and systematic separation, hierarchization and naturalization of sex (Hirdman 1988). The analytical separation of sex and gender has further been criticized for contributing to the "black-boxing" of the biological, gendered body (Haraway 1991: 197). It has also been criticized on the grounds that, in practice, it pays too much attention to biological differences. For example, in *Ekte kvinne? (Real Woman?)*, Eva Lundgren (2001) wrote that the sex/gender distinction per se could fuel the very thing feminists wish to avoid, namely a biologistic view of the body. Thus, by referring *sex* to the biological sphere, it is constructed as unchangeable and static (ibid.: 189).

In mainstream feminist theory and gender studies, the fear of essentialism for some time led many researchers to avoid the biological question by simply excluding "natural phenomena" such as biology and sex from their field of interest, entirely focusing on gendering processes (Holmberg 2008). However, in feminist science studies, the interest in developing new understandings of sex and sexual differences has never ceased to be present (Ahmed 2008). Since the 90s onwards, several what can be referred to as different forms of third-way approaches have been developed, aiming at bridging the gap between the biological and the social (see Holmberg & Palm 2009). For example, Lynda Birke, in her book *Feminism and the biological body* (1999), presents the thought-provoking idea that feminists have produced an image of bodies without organs – or rather, with reproductive organs only. Her point is that there are good reasons for feminists to avoid biological reasoning – the well-known risk of biological determination. Because of this, most feminist science studies have been engaged in reproductive genetics and technologies. Nevertheless, there is more to a body than x and y chromosomes, hormonal glands and sexual organs. Other, what appear as more gender neutral, organs and body parts are in need of feminist attention, too. Moreover, a feminist intervention would be to challenge the reductionist idea of free-floating organs altogether, and theorize the interconnectedness of processes and organs within as well as between bodies. This challenge has been taken up by several scholars (see also Haraway 1991).

Anne Fausto-Sterling, in her thorough work on sex-determination, has scrutinized the science and practice surrounding human sexuality through the example of intersexed bodies (2000). In this study, she highlights how the geneticists and endocrinolo-

gists of the 20th century strived to find the ultimate sex determining force, and how it varied from chromosomes, to hormones, to genes. Having said that, she is careful that this does not mean that biology does not affect us, but that this biology is not a state, but constantly ongoing processes. She is somewhat critical of the way feminist scholars, in her opinion, have avoided the biological question, claiming that it is altogether socially constructed. Fausto-Sterling thus concludes that a full understanding of human sexuality cannot be made without looking into all the layers and examining their interconnectedness, from historical forces, social organization and structures, culture, identity, to hormonal activities, cellular systems and genes. Genes do not, according to Fausto-Sterling, in themselves determine sex. Sex determination is a process in which genes, among other actors, play a role. I have elsewhere argued that this perspective is productive and helpful in, for example, presenting a conceptual framework enabling interdisciplinary work. However, it runs the risk of reducing "the social" to mere observable facts, avoiding issues like intentionality and consciousness (Holmberg & Palm 2009), as well as the dimensions of social critique.

The very influential idea of the body as *material-semiotic* has been developed by Donna Haraway (1991 & 1997). In short, this means that she calls into attention the simultaneity of materiality and meaning, the fleshy and the metaphor, fact and fiction, and by this Haraway refuses to reproduce the boundary between social and biological. As she argues, any such distinction must in itself be conceived of as artificial, always a result of power relations within techno science and modern nature cultures (Haraway 2000). As a

consequence of her approach, she too, like Fox Keller, questions the validity of viewing the gene as an icon, or, in her own terms, as a fetish.

> Organisms are whole in a specific, non-mystical sense; that is, organisms are nodes in webs of dynamic articulations. Neither organisms nor their constituents are things-in-themselves. Sacred or secular, all autotelic entities are defences, alibis, excuses, substitutes - dodges from the complexity of material-semiotic objectifications and apparatuses of corporeal production. In my story, the gene fetishist "knows" that DNA, or life itself, is a surrogate, or at best a simplification that readily degenerates into a false idol. The substitute, life itself, is a defence for the fetishist, who is deeply invested in the switch, against the knowledge of the actual complexity and embeddedness of all objects, including genes. The fetishist ends up believing in the code of codes, the book of life, and even the search for the grail. […] So the fetishist sees the gene itself in all the gels, blots, and printouts in the lab and "forgets" the natural-technical processes that produce the gene and genome as consensus objects in the real world. (Haraway 1997: 146)

The semiotic embeddedness of all material objects is the key to understanding the nature of genes, according to Haraway. A similar bio-social analysis is performed by sociologist Celia Roberts in her study of so-called sex hormones (2007). In this book, Roberts does not primarily address genetics, but all the same the hypothesis applies to genes as well:

> *Messengers of Sex* argues for a refigured view of hormones as messengers of sex, suggesting that hormones do not message an inherent or preexisting sex within bodes, but rather are active agents in bio-social systems that constitute material-semiotic entities known as "sex". (Roberts 2007: 22)

Clearly inspired by Haraway and by Paul Rabinow's conceptualization of "bio-sociality", Roberts' claim is that feminists must, besides engaging in critique of biological research, also do more theorizing about biological bodies. Elisabeth Wilson is another scholar concerned with the neglect of biological bodies by postmodernist feminists. But where Roberts engages with the feminist science studies tradition, Wilson does not more than marginally touch upon feminist research achievements. Nevertheless, she comes to a similar conclusion from a close encounter with neurological, depressed bodies; bio-sociality in her terms is labelled "bio-affective systems" (Wilson 2008: 387). Her point is that psychotherapy and anti-depressant drugs effect one and the same system, but in different ways. Thus, nature and culture cannot be distinguished as competing paradigms in depression treatment. A similar point has been made by an interdisciplinary group of Swedish scholars, investigating representations of the depressed person in interviews, science and media (Johansson et al. 2009). One of the strengths of their analysis is that they keep their connection to feminist theory.

To sum up, some of the most interesting work in the area of gender research and biology in general and genetics in particular is, in my opinion, today done by scholars – like those presented here – who have one foot in the natural or medical sciences, and the other in feminist science studies (Holmberg 2008). Perhaps it is this "double vision" (Kelly 1979) that has enabled these scholars to produce new ideas and transcend the sex/gender, nature/culture

divide that has become such a burden for feminist researchers. This divide has been criticized repeatedly, and as I have presented above, we now have some solid alternatives. However, it is important to build on the work done by earlier feminist scholars; the wheel does not have to be reinvented. Any feminist engagement with genetics should, in my view, build on constructivist insights, not view the biological or genetic body as a *limit* for constructivism but as a constitutive split phenomenon – a body that in itself "speaks the gap" or is built up by the gap (Holmberg & Palm 2009). In addition, it is part of a feminist project to honour those who should be honoured (Ahmed 2008). Of course, I will probably fail to do so myself in many respects in this brief overview.

Reproduction genetics

Emily Martin wrote, in her highly important paper on the egg and the sperm in biological textbooks, that cultural narratives and stereotypes on reproduction and heterosexual romance entered these textbooks and their representations of contemporary scientific facts (Martin 1996). Stine Adrian has shown how these heterosexual norms also enter the area of repro-genetic practice; the reproduction clinic (Adrian 2006; see also Franklin & Roberts 2006). In her study, it became evident how staff and becoming parents in practice mimic the natural conception. Several researchers within the field of feminist science studies have in different ways problematized how scientific knowledge production and cultural imagination become intertwined in reproduction genetics (Lie 2002; Lykke & Braidotti 1996; Spilker & Lie 2007).

One of the most influential scholars in the feminist science studies strand is Sarah Franklin. She has devoted much of her scholarly work to reproduction genetics (1997), and in particular in

a specific field: the cloning of non-human animals (2007 & 2008). Based on this work, she has developed the concept of "transbiology". Transbiology, in Sarah Franklin's rendering, describes the contemporary organization or rather reorganization of living matter, of what Foucault called "life itself". Transbiology is more than a description of laboratory practice, it also captures the "postmodern" diffusion of science into all imaginable spheres of society: popular culture, politics, economics, etcetera. Franklin builds on the trans-concept from Haraway (1997), and suggests that as the cyborg was helpful in understanding the contemporary couplings of biology, technology and informatics, so can transbiology be used as a tool to understand today's norm in biology – as something "not only born and bred, or born and made, but made and born" (2006: 171). Transbiological offspring – such as Dolly the cloned sheep – were at first miraculous because they where so normal. What makes Dolly a successful clone is, paradoxically enough, that she is both common and unique. Judith Halberstam has used Franklin's transbiology concept in a fruitful way, investigating the knowledge production taking place outside the laboratory, in wild life films and animal animations, as well as in horror movies (Halberstam 2008). She states that the concept helps in highlighting the transgressive intervention going on, in which traditional views in feminist theory of sexuality, genealogy, body and reproduction are challenged.

Many of the most interesting studies of reproduction genetics today similarly refer to the ways in which this research, along with the practices performed at the clinics, challenges norms and thus has a subversive potential. Although I believe this is sometimes true, I also think there is a need to keep the critical glasses in place. With the risk of simplification, remember that in the

70s, feminists considered reproduction technologies to be bad – portraying them as experiments on women for the sake of economic and scientific advancement. Today, feminists have largely embraced the cyborg idea and believe that IVF and assisted reproduction is a human right (for Western, able bodied women at least). But it is still an enormous industry, and it is still a matter of invasive treatments on women's bodies, causing a lot of harm, involving not least bio-ethical dimensions (see Höglund this volume; McKenzie 2007; Mulkay 1997). Another matter is that there is a need for feminist intervention and investigation concerning the use of animals in this area, something most often overlooked because of the complexity of the topic. Laboratory animals can be considered victims, sacrifices or workers, with different ethical outcomes. But they need to be considered.

Evolutionary genetics

In recent years, there has been what can be understood as a small revolution within feminist evolutionary biology. However, we should not forget that already in the early 1970s women biologists worked consciously to change the andocentric bias of evolutionary theories. In the early 1980s, Sarah Blaffer Hrdy published her highly influential *The woman that never evolved* (1981), claiming that female primates too lead interesting lives, however ignored by science. Hrdy also claimed that primate females compete fiercely over status and resources, a viewpoint very much in opposition with the, by that time, hegemonic idea of females as coy and caring mothers. Her standpoint could be categorized as a liberal, feminist socio-biologist one, also called Darwinian feminism. Others have followed, and engaged closely with evolutionary genetics, especially in sexual selection theory. Patricia Gowaty, for example, has

constructed a gender-neutral model for flexible mate choice (Gowaty & Hubbell 2005). But she has also engaged in conversations with feminism, asking the question: How can evolutionary biology and feminism benefit from one another (Gowaty 1997)? Griet Wandermassen, another example, states that feminism must learn from evolutionary theory and evolutionary psychology in order to fully understand and explain patriarchy (2004). This viewpoint can be criticized for its rather naïve view on evolutionary biology and science itself (Ah-King 2007). In addition, Malin Ah-King argues for a bilateral exchange, in which feminists can learn from evolutionary biology about variation and non-determinstic views of bodies, and feminism can contribute to evolutionary biology with its critique of the androcentric bias. By liberating biology from this bias, the oppression of women based on biological claims about what is natural can be challenged (Ah-King this volume). Other scholars have stressed how truths about human nature so nicely seem to be extrapolated from animal research and how (other) animals are interpreted in order to fit preconceptions about the same human nature (Andersson 2006; Zuk 2002). Some of the most interesting work done in this field of biology/feminism involves a problematization of our understanding of other animals; their complexity has been more or less ignored by feminist research (Fausto-Sterling 2000; Zuk 2002). Perhaps this is one of the most important insights from this coupling of evolutionary genetics and feminism.

Most scholars concerned with feminism and evolutionary biology have their background in the latter field. However, feminist scholars within the British literary and philosophy tradition have long been engaged in Darwin's theories as texts, most notably Gillian Beer, who demonstrates, among other things, the intertextu-

ality of science and literature (1983). This interest has spread to a more continental context (Fischer 2009). Moreover, there are some examples of well-established philosophers who have recently become more interested in genetics and biology (Braidotti 2006; Grosz 2008). Elisabeth Grosz is perhaps the one feminist scholar without a biological background who stands out as most intimately concerned with evolutionary biology. Her main argument is that Darwin's theories on natural and sexual selection are well worth a feminist inquiry. Grosz does not in this way embrace the whole package, but means that Darwinian feminism is too much of a "liberal reformism", aiming at correcting male bias. But, says Grosz, what if Darwinism, instead of being in need of correction, proves to provide an explanation of the power asymmetries and structures that exist (2008: 26-27)? The idea is striking. What if Darwin's theories could provide as much intellectual challenge to the humanities and social sciences, despite how much criticism has been produced by feminist scholars:

> Darwin's work may prove as rich, if not even more productive, for feminist thought as Freud's has been, in spite of it's nineteenth-century conceptions of the relations between the sexes because, like Freud, Darwin opened up a new way of thinking, a new mode of interpretation, new connections and forms of explanation – indeed a new discipline – that may prove useful in highlighting and explaining the divisions and connections between nature and culture (Grosz 2008: 28).

The connections between nature and culture and overcoming them are truly feminist endeavours, and in sum, the area of Darwinian feminism and what can be called feminist Darwinism is a

growing and vivid one, and it will be very interesting to see which directions it will take and the impact it will have on mainstream feminist science studies and vice versa.

Geneticists and genetics

Evelyn Fox Keller's book *A feeling for the organism* portrays Nobel Prize winner Barbara McClintock's work (Keller 1983). According to the captivating biography, McClintock practiced a very special style of research. She advocated an individualized approach and stated: "You need to have a feeling for every individual plant" (Keller 1983: 198). In addition, the feeling for the organism also meant that the organism, the living form, "communicates" with the experimentalist, if only we take the time to "listen". McClintock therefore advocated *slow science* – as a sharp contrast to the culture of quick results that researchers describe today. Moreover, researchers need to be aware of the limitations of scientific inquiry.

> For McClintock, reason – at least in the conventional sense of the word – is not by it self adequate to describe the vast complexity – even mystery – of living forms. Organisms have a life and order of their own that scientists can only partially fathom (Keller 1983: 199)

To understand living organisms, according to McClintock, you need to have a feeling. Now, Fox Keller has been criticized for advocating a certain female style of research, idealizing and essentializing the female. I think the critique is unfair, and that what she is actually doing is presenting an alternative, marginalized story of how genetics can be done – genetics that is not about the nature/culture divide through the domination of nature by the detached and objective scientist. This methodological strategy is

today a well-known one, demonstrated perhaps most effectively by Donna Haraway. Scientific origin stories are stories about dead, white men and their scientific breakthroughs and discoveries, and these are the stories that we inherit (Haraway 1989). Who, for example, has not heard of the discovery of the DNA-structure by James Watson and Francis Crick? But what about the story of Rosalind Franklin, the woman who made invaluable contributions with her x-ray experiments, but who no one seems to remember? One feminist strategy has thus been to widen this male-biased history, from the 19th century onwards (Schiebinger 2001; see also Götschel and Bergwik in this volume).

There is another reason why paying attention to geneticists is valuable; throughout the 20th century, there has been a close connection between, a co-construction of, genetics, medicine and politics, and geneticists have been central actors in for example the eugenics movement (Bengtsson 1999; Koch 2009; Proctor 1988). There is no reason to believe that this connection is now over. Towards the end of the 20th century, what seemed to be unlimited resources where poured into the genetic/genomic industry. Throughout the 90s, genetics was rendered iconic status, thus giving geneticists a similar noble position. If we have now entered the genomic era – genomics being the new paradigm of biological organization – I would like to see more scholarly work on genomics – it's actors, representations and knowledge production – from multiple feminist science studies perspectives.

Outlooks

As we will see in this exciting volume, the contemporary conversations and transgressions over the nature/culture divide taking place in feminist science studies are certainly many and fruitful.

Whether primarily focusing on physics, physics education, animal studies, bioethics, environmental studies, history of science, neuroscience or genetics, there is an impressive amount of work going on. As can be noted in this broad and comprehensive collection of articles, some areas of feminist research over the gaps are more vivid than others. The area of nature and environmental studies has long been a central one for eco-feminist concerns and interventions, and has recently been re-vitalized with a new "generation" of more transgressive research, making gender if not a fully integrated perspective, at least one with some influence on/in environmental studies (Scheich this volume). This area will, I think, expand even more as climate and environmental concerns grow and the need for cross-disciplinarity becomes more pressing. Bioethics is also an area where feminist and gender perspectives have developed and is slowly moving towards an integrated position (Höglund this volume). Ethics has also become an integrated part of mainstream feminist theory, as scholars such as Braidotti (2006) and Haraway (2008) explicitly engage in the bioethical debate. Braidotti writes in her book on Transpositions – a concept borrowed from Evelyn Fox Keller's reading of Barbara Mc Clintock – about trans as admitting "alternative ways of knowing" (2008: 6), that is, both epistemological and ethical issues are at stake. Braidotti advocates a post-humanist, nomadic perspective in which transpositions stands for a sustainable ethics (33).

Gender in science has been a hot topic historically as well as in contemporary debates. The over-representation of men has become increasingly embarrassing for science, and thus historical analyses such as Bergvik's (in this volume) can shed light on some of the dynamics at work in excluding women. Most interestingly perhaps, such work also makes visible the networks and strategies

that enable women scientists to succeed, despite the harsh conditions. This kind of research has also had an impact on research politics and equity policies (Schiebinger 2001). Science and physics education is another area where gender research and perspectives have made an impact. As Danielsson points out, even though most of the gender studies are in fact about female under-achievements or sex-differences in student learning styles, there are some comforting signs of a more critical trend within the tradition of science education (Danielsson in this volume). More pressing is perhaps the area of feminist science studies of knowledge production in physics. As pointed out by Götschel, critical studies of the gendering of physical knowledge is still very much a blind spot, and the few promising examples that do exist have not yet had any impact on, or engagement with, the epistemology of the physical sciences. But, as Götschel reminds us, interventions in "numbers" along with education efforts might indirectly create some interest from physics (Götschel this volume). Karen Barad (2008) and a handful other feminist science scholars have certainly contributed to the slowly increasing interest in knowledge production in physics from feminist science studies and gender scholars.

Animal studies and feminism have many, in my view, underexplored intersecting points of interest. Power relations, naturalized ideological and capitalist systems as well as more cultural and symbolic dimensions bring the two areas together (Birke 1994 & 2002). Despite this, as pointed out by Fox (in this volume), while gender and feminism have had at least some impact on the interdisciplinary field of animal studies, the role of other animals in feminist (science) studies is a rather invisible one. There are, of course, some very important exceptions (for example Birke et al. 2007; Braidotti 2006; Haraway 1989, 2003 & 2008). Non-human

animals are also present in Ah-Kings contribution to this volume, and similar to the story of animal studies and feminist research, while "rainbow animals" and the queer perspective on evolutionary biology has made some impact on biology itself, it has not been given much attention in feminist thinking (Ah-King 2009; Giffney & Hird 2008). I have a strong conviction that we will see more of non-human animals in feminist research, with the current post-humanist and materialist "turn".

When it comes to gender studies and neuroscience, which obviously constitutes a burning relationship, we have a rather long tradition of feminist critique, but not so many conversations. Kaiser (in this volume) gives a promising example of how such conversations could take shape, from a within science perspective. These conversations could, in my view, well include feminist scholars with bio-social, nature-culture concerns and approaches.

While reading the different chapters in this book, one can conclude that the gaps between feminist inquiry and science, so often emphasized in the past, are on their way to being changed. We can no longer talk about absolute gaps, such as for example between the natural and cultural sciences, or about the gap between sex and gender. On the contrary, the gaps discussed in this volume are both flexible and productive. Science, in this respect, certainly makes many connections with contemporary gender theory and feminist concerns, and future conversations may well take some unexpected directions.

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HELENE GÖTSCHEL |The Entanglement of Gender and Physics: Beings, Knowledges and Practices[1]

Introduction

Gender is one of the core categories of our culture and society. It is also a central object of sociological and cultural research. Additionally, gender plays a vital role in the design of natural and technological sciences. This has not yet been sufficiently studied. In Western industrial nations, certain disciplines such as physics, information technology, and electrical engineering are considered to be male fields of competence, and the proportion of women in these areas is comparatively small. Ironically, knowledge of the natural sciences and technological artefacts is regarded as "objective" and unrelated to gender. However, a number of works in science studies and gender studies have revealed that the predominant societal conceptions about gender are engraved in the worldview of both natural science and technological artefacts. I would like to elaborate on this assertion with a critical investigation of gender in physics.

Modern physics examines all processes that can be measured or proven via experiments as well as phenomena of the inanimate and increasingly also of the animate world. To exemplify this point, neuroscience is expressed and defined through mathematical equations and formulas. Physicists select the measurable phe-

1 I would like to thank Eva Hayward, Martha Blomqvist, Rebekah Fox, Skuli Sigurdsson, Staffan Bergwik, Tora Holmberg, and all colleagues at the Centre of Gender Research at Uppsala University for their helpful comments on early drafts of this chapter. I also wish to express my gratitude to Chris Baudy for translating an earlier version of this essay from German to English.

nomena out of the many existent ones and establish mathematical relationships between them. In other words, central to their work is the "objective" description of such entities via so-called natural laws. In the following, this kind of scientific research area will be referred to as "doing physics". Only a trans-disciplinary approach to physics can reach beyond the boundaries of physics as well as examine the contexts of development and application of physics through a gendered perspective; that is to say, gender research in physics is inextricably linked to an extended socio-cultural understanding of physics. Throughout this article, I will describe this trans-disciplinary approach to physics as "critical physics research".

Analytical dimensions of feminist and gender research in physics

Feminist and gender studies in natural science and technology have been carried out in North America, Australia, and Europe since the 1970s (Götschel 2001a, 2001b; Keller 1995, 2001). In comparison to the English-speaking countries, gender research on science and technology in German-speaking countries has only recently been conducted in academia. Instead, "feministische Naturwissenschaftskritik (feminist critique of natural sciences)" – as this area of research was called in the former Federal Republic of (West) Germany – has been discussed since the mid-1970s in an independent, "autonomous" context of the new women's liberation movement, for example at the annual self-organized "Conferences of Women in Science and Engineering" and in the context of new social movements such as the environmental movement or the "Alternativbewegung (alternative lifestyle movement)" (Götschel 2001a, 2001b). This debate on "feminist critique of natural sciences" was carried out almost exclusively by women and was critical

of both the environmental risk of and the gendered assumptions imbedded in the natural sciences and technology; this was more of a political discussion than the US-American debate on "Gender and Science" (Keller 1997). Texts were published in conference proceedings, anthologies or "grey literature" such as brochures and pamphlets, but almost never in academic journals. These different political and publication contexts explain the variations and specific characteristics as well as the delayed reception of the German-speaking debate in comparison to US-American papers on Gender & Science Studies in academia internationally and, more surprisingly, within gender research in Germany itself.

During the first half of the 1980s, ground-breaking studies emerged in West Germany in which female physicists specifically dealt with their own scientific disciplines by analysing the knowledge of physics from a gendered perspective (Rübsamen 1983, Scheich 1985). By now, an international array of researchers from numerous fields - such as physics, philosophy, sociology, science research, history, literary studies, and other areas of research - have examined the actors as well as the organizational structure, objects of inquiry and theories of physics, and the transmission and popularization of physics from a gendered point of view. These scholars are exploring the possibilities, ways and means of applying to the field of critical physics research approaches, methods and theories that have been developed in other disciplines and trans-disciplinary areas. Therefore, a sensible systematization of feminist and gender studies in physics follows the respective epistemological interests and the objects being examined. Taking Keller's system "women in science, science of gender, and gender in science" (1995) for the natural sciences and its further development by Heinsohn (1998) and Bauer (2006) into account, I suggest

the following three dimensions of analysis in regards to gender and physics[2]

- Actors and organizations in physics
- Gender analysis of knowledge of physics
- Equal opportunities in the production and teaching of physics

I will explicate these three dimensions with examples of fundamental studies of critical physics research in literature from Scandinavian countries, German-speaking countries, and texts written in English.

Actors and organizations in physics

Anyone trying to relate physics to gender might begin by inspecting the working life and conditions that male and the few female physicists encounter when they work in academia, industry, or education. Such investigations have been instigated by physicists who have combined national and international forces in working groups, societies, and networks such as the "Arbeitskreis Chancengleichheit (AKC)" (Working group for Equal Opportunities) of the "Deutsche Physikalische Gesellschaft" (German Physical Society), the "Nordic Network of Women in Physics (NorWiP)" or the global "Working Group on Women in Physics" of the "International Union of Pure and Applied Physics (IUPAP)". These organizations, at least in part, have committed themselves to modern physics in their respective societal and cultural contexts (Bargstädt-Franke 2002; Thörngren-Engblom et al. 2002; Zilles 1999).

Within historical and sociological studies, there has been an exploration of the situation of women (and men) working in the field

2 Earlier approaches similar to the one presented above were developed by Rübsamen (1993, 1995), Lucht (1997, 1999) and Berner (2004: 82-103). Schiebinger (2000, 2008: 5), in contrast, suggests as levels of analysis (i) women in science, (ii) the culture of science, and (iii) the knowledge of science.

of physics. Statistics reveal that the proportion of female physicists employed in industry, at a university, or in research institutes outside the university system as well as in the individual subsections of physics varies considerably (Benckert 1997; Bessenrodt-Weberpals 2003; Könekamp et al. 2002). International comparisons show that the low share of women in Western industrial countries is not to be taken as a natural fact. In 1990, for instance, the number of university women lecturers in physics ranged worldwide from under 5% to over 30%. In Japan, Canada, Norway, and in the Western provinces of Germany, very few female physicists held the chair of physics at a university. In contrast, the proportion of female professors of physics made up approximately one third or more in Portugal, Hungary, the Philippines and the former Soviet Union (Megaw 1992). The ongoing, EU-funded project "Understanding Puzzles in the Gendered Map of Europe UPGEM" – coordinated by Danish anthropologist Cathrine Hasse – attempts to understand why some of the European countries (in the southern and eastern part) are better that others (in the northern part) at attracting female scientists to a research career in the natural sciences (Hasse et al. 2008). Interviews, qualitative sociological, and biographical studies offer insights into the appeal of doing physics, but also into the discriminatory structures female physicists are exposed to during their education or in the working world (Bessenrodt-Weberpals 2003; Erlemann 2004b; Keller 2001; Könekamp et al. 2002; Lucht 2004; Lundborg and Schönning 2006; Traweek 1988). These structures are frequently paired with anti-Semitic biases, as in the case of British crystallographist Rosalind Franklin (Wiesner 2002: 125–181), or with racist prejudices, as in US-Amer-

ican physicist and historian of science Evelynn Hammonds's case (Sands 2001).[3]

Analysis of female physicists is being carried out in both historical and biographic studies. There are insightful studies available about the first female professor in Europe, the 18th century physicist Laura Bassi (Ceranski 1996), about the first Prussian female physicists (PhD received in 1899), Elsa Neumann (Vogt and Pussert 1999) as well as about Lise Meitner (Scheich 1997; Sime 1996), Hertha Sponer (Maushart 1997; Tobies 1996) and Hedwig Kohn (Winnewisser 1999, 2003) – these three physicists were habilitated (qualified for professorship) prior to 1945 at a German university. Recently, research has been conducted on the first Swedish female assistant professor in physics Eva von Bahr, who was productive as a scientist between 1908 and 1914 (Wennerholm 2007). Not only biographies of these individual physicists are available, but also works on historical couples and collaborations in physics such as Albert Einstein and Mileva Marić (Maurer 1992; Pycior, Slack and Abir-Am 1996), on the occupational group of professional female physicists (Rossiter 1982, 1995; Sandner 1999), on individual research institutes such as the Wiener Institut für Radiumforschung [Vienna Institute of Radium Research] (Bischof 2003; Rentetzi 2007), the Kaiser-Wilhelm-Gesellschaft [Kaiser Wilhelm Society for the Advancement of Science] (Vogt 2007) or the Cavendish Laboratory, the Department of Physics of the University of Cambridge (Gould 1997), and on the networks of female physicists (Götschel 2001a, 2003b). Brigitte Bischof (2003)carried out a systematic search for female physics students and physicists

3 Although some important preliminary work has been done (e.g. Jordan 2006), intersectional investigations on physics have not yet been thoroughly attended to. Up to now, most historical and biographic studies portray white middle class and upper class women scientists without taking into account that various socially and culturally constructed categories – such as gender, race, and class – interact on multiple levels.

at the University of Vienna and the Institute of Radium Research, respectively. The institute was founded in 1910 and was the result of a collaboration between the University of Vienna and the Öserreichische Akademie der Wissenschaften (Austrian Academy of Sciences). Bischof discovered the names of more than one hundred female physicists who had been obscured from history. She suggests that between 1910 and 1945, seventy of these women either researched their doctoral theses at the Institute of Radium Research or were employed as assistants or even worked as freelance scholars - Elisabeth Rona, Marietta Blau and Berta Karlik, to name but a few. The annual proportion of female physicists was 22% at this research institute, and increased up to 57% during war times! Bischof advances three reasons why such an extraordinarily large proportion of women could work at the Radium Institute. Like spectroscopy (Tobies 1996), radioactivity too was an up-and-coming branch of physics and this gave female physicists the chance to pursue interesting questions within new not yet rigidly gendered research structures, as compared with the more well-established branches of physics. These women certainly also took Marie Curie as a role model, a scientist who had received her second Nobel Prize in 1911 for her research on the discovery of radium that was carried out in Paris, and met numerous female employees of the Radium Institutes in person. First and foremost, however, Bischof underlines the importance of the institute's first director Stefan Meyer's favourable attitude towards scientific research being studied by women and his unreserved support for them. Lise Meitner's former supervisor considered women to be capable physicists and apt professionals. The national socialist dictatorship, however, stopped the careers of most of them because of their Jewish background, their political attitude, or their

gender. Astonishingly though, after the war, this great number of women physicists in these areas of physics research had slipped into oblivion. Furthermore, the view still and stubbornly prevails that only in recent years has the female proportion of undergraduates and PhD students of physics reached the 20% mark in Sweden and exceeded the 10% mark in Germany; and this is often seen as a story of progress (Benckert 1997; Könekamp et al. 2002).

Gender analysis of knowledge of physics

While a great deal of historical and sociological research has been undertaken on women in physics, not much work discusses how gender informs and shapes knowledge of physics. For many, there appears to be no interaction between knowledge of physics and gender (Potter 2001; Rübsamen 1993). It would seem that no sex or gender can be assigned to the objects of investigation in physics and their formulas and laws. People doing physics admit that language and theory development can mirror socio-cultural influences, such as the naming of a planet "Venus" or the description of the "virgin state" of matter in magnetism. Yet in the logic of physics, such terms are viewed as merely an inspirational matter or trivial names of facts rather than as part of the core explanations of the discipline. A trans-disciplinary viewpoint, though, reveals that (i) knowledge of physics makes statements about gender, (ii) societal notions of gender feed into the description of the material world, and (iii) epistemological reflections on physics relate to gender. Physics advances ideas about men and women, about masculinity and femininity. For example, around the year 1900, scientists inferred from the laws of thermodynamics that women would only be able to follow their "nature" and give birth to healthy children,

if they avoided intellectual work and did not waste their energy by working as professors in academia. In this way, the concept of energy conservation was used to prevent the rivalry between men and women in academia (Heinsohn 2000, 2005). Furthermore, presentation of the history of physics as a male genealogy, a "male teacher – male student" relationship or as a religious club of men clearly shows which gender may or may not enter upon the cultural heritage (Erlemann 2004a; Lucht 2001, 2004; Traweek 1988: 77; Wertheim 1998). Such attributions become very apparent in popularized physics, where, for instance, the proton "Protoni" is described as a "poor lonesome cowboy" (Gisler 2001) or where the advertising for research projects in particle physics employs a quasi-religious rhetoric (Rolin 1999: 526). Other writings discuss the language of physics, especially in the nuclear arms race and the military (Cohn 1987; Easlea 1983) or in high-energy physics (Götschel 2006; Traweek 1992).

Because physics is a wo/man-made discipline, it does not come as a surprise that societal gender relations are carved into the knowledge of physics. The disregard for female reproduction work is reflected in the scholastic theories of the early modern mechanical movement; this erasure is continued in Newton's laws of motion (Scheich 1985, 1993). Seventeenth century English notions of class and gender influenced the interpretation of experiments with the air pump, which were inscribed into Boyle's law of gases (Berner 2004: 99–102; Potter 2001). Ideas about hetero-normativity and the patriarchal, nuclear family are mirrored in the standard model of elementary particles (Götschel 2006). Notions of patriarchal hierarchy can be traced in the understanding of scientific theories and the conceptualization of particle physics (Rübsamen 1983; Whitten 1996). Although some important preliminary work

has been done, critical investigations of how gender informs the knowledge of physics have not yet been thoroughly attended to.

Epistemological reflections on the attributes of experimentally produced "nature" can also be considered from a gender point of view. Objectivity, as it is discussed in the US-American feminist philosophical discourse, can be understood as socially negotiated knowledge, as a reflection of cultural values that need to be reworked, or as partial and situated knowledges (Longino 1990; Harding 1994; Haraway 1988). A particular case in point is Karen Barad's theoretical work on materiality in physics (1998, 1999, 2001, 2005, 2007). Barad, who has a PhD in theoretical physics and is professor of feminist studies at the University of California, Santa Cruz, explores "how matter comes to matter" (Barad 2001) through an analysis of piezo-electric processes that occur in ultra-sound measurement instruments when used in fetal examinations. She aims at developing a feminist theory of "agential realism" that overcomes the dichotomy between discovery/subject/culture (epistemology) and being/object/matter (ontology) and leads to "epistem-onto-logy". Barad's theory rests on Judith Butler's theory of performativity (e.g., 1993) as well as on other US-American philosophical discourses. To Barad's mind, postmodern feminist theories focus one-sidedly on cultural representations of objects and too little on the objects themselves. As a physicist, she cannot relate to the linguistic argument that words produce bodies, because it is not possible for physicists to realize every postulated event in an experiment. In Haraway's sense (e.g., 1991), however, bodies in material sciences can be understood as resistant and actively performing entities that humans can interact with. Barad takes up this idea and talks about "intra-actions" in order to show that research subjects and research objects come into

being through this process. In so doing, she picks up Niels Bohr's physical-philosophical interpretation of quantum mechanics (e.g., 1929, 1957). In Bohr's "Copenhagen Interpretation", the unusual performance of small particles compared to macrophysics can be explicated in that the observed characteristics only come into being during the process of observation. Here, Barad discovers parallels to the performativity of the discourse practice as it pertains to post-modern feminist theories. Like discourse practices, physical measurement instruments create materiality. This "intra-action" with bodies, Barad argues, must be taken into account in feminist theories just as the production of materiality via discourses and performativity must also be (Barad 2007).

Equal opportunities in the production and teaching of physics

Many feminist researchers doubt that it is possible to develop a new type of physics (Keller 1987; Harding 1994: 92-118; Rolin 1999; Schiebinger 2000: 213–239). The analysis of knowledge of physics does not render any indication of its change. Male physicists in particular often pose the polemic question of "whether or not a stone drops differently when dropped by a woman or man." But, regardless of their gender, female and male researchers cannot develop physics outside their social and cultural contexts (Bug 2000; Rübsamen 1991; Whitten 1996). The proportional increase in female physicists, for example by changing the unwelcoming culture that many women encounter across the discipline (Erlemann 2004a; Lucht 2004; Münst 2002; Seymour and Hewitt 1997: 88–183), is a necessary, but not a sufficient condition for the gender-democratic production of physics. In the literature, there are mainly two strategies discussed as interventions: one is the

integration of gender aspects into research on physics, for instance into the history of physics or didactics of physics, the aim being to produce a long-term effect on the discipline's culture or even the knowledge of physics itself (Benckert 1997; Rübsamen 1991, 1992). The other is the concentration of physical and gender competencies via trans-disciplinary research questions and research teams, respectively (Schiebinger 2000: 241–259, 2008: 20–21). The task of such teams might be to critically examine and revise – with gender aspects in mind – the process of physics development, for example, with regard to the selection of research questions or the linguistic description of research results because "[w]omen's studies and feminist theory have insights to offer physics - if physicists would only permit it!" (Bug 2003: 893).

Within the field of physics education research, a first reorientation has taken place and new curricular and didactic approaches have been developed for schools and universities aiming to include persons of all learning styles and genders. Doubtlessly, the danger of reifying traditional gender roles must be reflected upon (McCullough 2004; Davidsson 2007). Gender-democratic teaching of physics in schools draws from educational research (e.g., Häußler and Hoffmann 1999; Hoffmann 1990; Hoffmann, Häußler and Peters-Haft 1997; Kessels 2002; Stadler 2005) as well as from the practical experiences of physics teachers (Cavicchi, Hughes-McDonnel and Lucht 2001; Frank 2003; Lucht and Rübsamen 1990; Kessels, Rau, and Hannover 2006; Sandner and Walz 2004). Central to a more gender-democratic teaching of physics, at least in part, is to consider young women's interests in the design of contents and work forms. New forms of teaching and learning and innovative study contents can also improve the appeal of physics at the universities (Bessenrodt-Weberpals 2005, 2006, 2007; Münst

2002; Whitten and Burciaga 2000). At the University of California, Los Angeles, Byers designed an "Introduction to Nuclear Physics with Biographies of Women Physicists" (Byers and Williams 2006; Wertheim 1998: 332). Barad extended her "Introduction to Quantum Physics" at the Claremont Colleges (California) with feminist and philosophical questions on quantum reality (Barad 1995). Examples of trans-disciplinary courses for students of physics, gender studies, science studies, and educational science are "Situated Knowledges: Cultural Studies of 20th Century Physics" by Barad (Barad 2000; Musil 2001) at the Claremont Colleges as well as lectures and seminars of the module "Gender Studies and Natural Sciences" by Bauer, Götschel and Heinsohn at the University of Hamburg, Germany (Bauer and Götschel 2006; Götschel 2003a; Heinsohn 2003).

The module "Gender Studies and Natural Sciences" at the University of Hamburg offers trans-disciplinary classes at introductory, advanced, and research levels. Students choose four elements out of six depending on their interests and the guidelines of their major studies. They begin with a course at the introductory level that either deals with sex and gender as the main focus or centres on broader fields of interest such as general ethical questions including mainstream gender aspects. The advanced level seminars offer an in-depth treatment of the following three areas: epistemological questions, (historical) scientific controversies, and the question of the socialization of scientists. Students who have successfully completed introductory and advanced courses will have acquired a basic understanding of the field and are then able to carry out their own research projects. The emphasis is on fostering students' skills to link their theoretical knowledge to empirical research methods. The advanced class, for instance, could focus

on "experiments" as a central topic, and the students would learn how to observe the role of experiments in laboratories or classrooms according to ethno-methodology and then write a research report. The seminar could also concentrate on "scientists" and the students would learn how to do research in historical science or social science as well as how to create a website or organize an exhibition. While there is some research being done on equal opportunities in the instruction of physics, there is still a need for research in creating empirical examples of how gender analysis can help to develop and apply physics in a gender democratic way.

Gender goes physical - current developments and open research questions

As regards actors and organizations in physics, numerous scientific studies have emerged worldwide. Literature that has not been written in English, though, is virtually unknown internationally – a case in point being the biography on the cosmopolitan physicist Tatiana Afanaseva-Ehrenfest (Litvinko 2002, 2003), which has been published in Ukrainian and Russian. Such works limit their objective to feminist research on female physicists. In contrast, research on male physicists from a gendered perspective, such as the critical reflection on Richard Feynman, the physics idol (Barad 1995), is rare. Although difficult to locate, there are historical and biographical texts on Isaak Newton, Robert Boyle, and Michael Faraday (Fara 2002; Potter 2001; Whitten 2001). Moreover, Wertheim (1998) presents the socio-cultural history of physics as a religiously inspired activity practiced within a male priestly community.

Gender-democratic pedagogy with regard to physics is the concern of physics education research and is often considered in

connection with questions on technical or vocational training. Yet so far, not every process has been studied, let alone understood. With reference to post-structural gender theory, Anna Danielsson (2007) follows a new path and examines "the gendered doing of physics" by looking at the identity formation of undergraduate physics students in relation to laboratory work. While many educationist studies reify gender differences by looking for gender differences, Danielsson asks (i) how people doing physics develop their gender identity in dealing with the predominant ideas in physics on "practical masculinity" and "analytical masculinity" delimited against "normal femininity", and (ii) what differences follow from this in relation to the development of an identity as a male or female physicists.

Currently, only a handful of researchers are covering in their analyses the dimensions of knowledge of physics and its production. They belong to the fields of women's studies, gender studies, science studies, history of physics, philosophy, physics education, psychology, and physics itself. The systematic analysis of the theories and methodologies employed (Scheich 2004) is still in its infancy, as is the inclusion of approaches from physics in the development of new theoretical and methodological concepts (Barad 2001, 2005, 2007). Many possible questions have not yet been examined in critical physics research. There is still too little known about critical approaches, the kinds of conditions and contexts that induce innovative ideas and their integration into the knowledge system of physics, as well as the role that cultural contexts and their gender system play here.

I would like to explicate this thought by way of conclusion. Take, for instance, the "parity violation" of the weak interaction in nuclear and particle physics. For a long time, people believed

that these reflexion symmetry processes in atomic nuclei would take place symmetrically, similar to the fact that when a screw with a dextrogyrate thread is mirrored twice, then the image of another screw with a dextrogyrate thread emerges. When theoretical physicists Dsung Tao Lee and Chen Ning Young proposed experimental tests for "parity violation" of the weak interaction, Chien Shiung Wu took this play with thoughts seriously and shocked physical experts by proving in 1957 that the processes in the Cobalt-60-Nucleus do not run symmetrically. A great deal has been written about whether Chien-Shiung Wu, a female Chinese-American physicist at Columbia University, had been unfairly denied the Nobel Prize - the very prize that was awarded to Lee and Young in the same year as Wu's discovery - and about how complex a role Wu's gender and her status as an experimental physicist had played in this (Benczer-Koller 2006; Cooperman 2004; Fölsing 1990). But so far, no one has studied how intersectionality functioned in this particular case. Could it be that these three physicists were able to describe nature as being asymmetrical because they have been brought up in a non-Western culture? How do race, ethnicity, and gender inform physics practices? This example shows that in critical physics research, gender analyses must be even more tightly linked with other categories of social inequality and cultural differentiation. In the future, it would also be desirable if more actors in cultural and sociological gender studies, with their knowledge of feminist methodology and theory construction, were to contribute to critical physics research. Moreover, people doing physics, with their competencies in and knowledge of physics and their practical experiences, must consider playing an active part in the trans-disciplinary debates about gender research in physics.

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ANNA DANIELSSON | Gender in physics education research: A review and a look forward

Introduction

In their guest editorial on the future of physics education research in the American Journal of Physics, physics education researchers Heron and Meltzer (2005) write:

> We highlight those directions that address intellectual issues that are specific, but not necessarily unique, to the subject matter and reasoning of physics. Therefore we omit important work on investigating gender-equity issues, for example. (390)

Thus, in their discussion on the future of physics education research, they give gender issues no consideration at all – claiming that such issues are not tied to physics as a discipline. Yet, within the physicist community, issues of female under-representation (and sometimes underachievement) have been intensely debated for decades. An article by Ambrosia (1940) is an early example of discussions on 'teaching physics to women'. Her main suggestions concern teaching subject matter more closely aligned with women's experiences and using students as peer instructors in the student laboratory. Later, the issue of women/girls/gender and physics education has been intensely discussed and researched. Usually, articles on the issue take as their starting point that the

low number of females taking physics is a problem that needs to be solved.

This is well in line with the broader discussion on 'women and science'; the participation of women in science is a highly debated area, and the focus has typically been on how to attract more female students. Berner (2003) and Johnstone and Dunne (1996) have examined the assumptions about gender and science that have underpinned discussions of a more inclusive science teaching. Johnstone and Dunne (1996) described one type of research as being centrally concerned with documenting differences in achievement or participation, sometimes seeking explanations for these differences in biology. Berner (2003) characterized this research as 'sex-roles research'. Another strand of research seeks social explanations for gender differences, such as the effect of parental influence (Johnstone and Dunne 1996). What these perspectives have in common is an epistemological view that their findings represent the 'truth' about boys, girls, and science. Conclusions are of the type that girls, for example, prefer a certain kind of learning environment. From this perspective, 'a change in the situation, then, requires either girls to have experiences that compensate for their deficiencies or for the school learning environment to be altered to compensate for the learning styles of girls' (Johnstone and Dunne 1996: 58). Further:

> What must be recognised here is that the oppositions that are constructed, within both the research and the interventions which are developed from it, are constitutive of gender. They produce and reproduce the categories that they are assuming to describe. Ironically, in this production, the relationship that the research is seeking to challenge – the dominance of the masculine over the feminine – is reproduced through these oppositions. (Johnstone and Dunne 1996: 59)

What Johnstone and Dunne (1996) are arguing for is research that tries to understand the dynamics of gender construction, that looks at how the dualistic gender relation is produced and reproduced in social practices, practices of which the said research is a part. Berner (2003) describes how contemporary research has increasingly turned away from the previous, often very passive view of female students as 'victims', either of biology or of socialization, and now instead focuses on their conscious choices. In this view, gender is seen as a question of choice and performance, rather than of biological, inborn behaviours or socialized norms. Here, the focus has increasingly moved towards looking at within-gender variations, their dynamics and diversity, not viewing gender as a simple dualism.

So far, I have provided a general introduction to how issues of gender have been approached within the broader realm of science education research. In the following, I will focus on one scientific discipline, analysing the physics education research that explores gender issues.

Review method

This review explores studies on gender and physics education research, broadly defined. This means that not only physics education research articles have been included, but also articles from science education research dealing explicitly with physics. Journals that regularly publish articles on physics education research as well as the highest ranked science education journals and the database ERIC were searched using their online search engines and the search words listed in Table 1. Further, the list of annotated references on gender issues in physics/science education compiled by Mallow and Hake (2002) was also scrutinized. I also used Murphy and Whitelegg's (2006a, 2006b) review of the research on the participation of girls aged 11–16 years in physics.

After reading a large number of abstracts, fifty-seven articles were judged to be relevant to the review and chosen for further analysis. I read these articles and wrote short summaries of them. The summaries were then sorted into preliminary categories. I then re-read the articles and the summaries several times, focusing on how they approached the issue of gender in physics. Questions posed during the readings included: Is gender problematized or treated as a synonym for 'girls and boys'? What kind of research methodology is employed? What view of learning is expressed in the article? Is physics problematized? Finally, I was able to group all articles into one of five categories: 1) Comparisons of male and female students 2) Textbooks and tests 3) Classroom practices 4) Teachers' attitudes 5) Critical perspectives

Journal/database	Search word(s)
Physics Education	gender, girl, women
Physics Education	gender, girl, women
Physics Teacher	gender, girl, women
American Journal of Physics	gender, girl, women
European Journal of Physics	gender, girl, women
Gender and Education	physics
Journal of Research in Science Teaching	gender AND physics
International Journal of Science Education	gender AND physics
Science Education	gender AND physics
Research in Science Education	gender AND physics
Physical Review Special Topic Physics Education Research	gender, girl, women
ERIC	gender AND physics

Summary of findings

Broadly speaking, there are two types of publications among the examined articles: teachers' sharing of experiences and ideas and research studies. The focus of the literature review will be on the research studies; when an article deals with teachers' sharing of ideas and experiences, this is clearly indicated. The majority of research studies (17 out of 30) were found to be quantitative in nature. As discussed above, five categories were constructed empirically based on the readings of the articles. In the following, these categories will be used to structure the review; each category will be introduced with an overview of the articles in that category. Then, an illustrative example of one or a few studies in the category will be presented in somewhat more detail. Considering the small number of articles published within the area, I have chosen to structure this literature review qualitatively rather than quantitatively, focusing more on exploring the occurrence of different

themes and methodologies than on the number of articles applying, for example, a particular methodology.

Comparisons of male and female students

The most common way to apply a gender perspective is by comparing male and female students. This can be done in terms of performance and ability, measured using grades (Wee and Baaquie 1993; Stewart 1998; Tai and Sadler 2001; Hazari et al. 2007), performance on tests (Zohar 2003; McCullough 2004; Forster 2005), relations between problem-solving performance and representational format (Meltzer 2005), interest in physics (Jones and Kirk 1990; Häussler et al. 1998; Williams et al. 2003) or attitudes towards physics (Reid 2003; Angell et al. 2004). There are also studies on the effect of high school physics preparation and affective factors on performance in introductory university physics (Hazari et al. 2007) and factors mediating the effect of gender on students misconceptions about electrical circuits (Sencar and Eryilmaz 2004). Udo et al. (2001) examines the effect of gender on students' feelings of science anxiety. Woolnough and Cameron (1991) reports on an evaluation of a course in which boys' and girls' reasons for choosing physics and what kind of assessments they preferred were compared. Another kind of comparison is the cross-country comparison made by Menard and Uzun (1993), in which the numbers of women studying physics in the U.S. and in Turkey are evaluated, and the countries educational systems compared and discussed in relation to this.

One example of a study typical of this category could be that of Reid (2003). In his study, boys' and girls' attitudes towards science in general and physics in particular were surveyed. Towards the end of primary school, both boys and girls were found to have

very positive attitudes towards science and considered it an important subject. Towards the end of the second year of secondary school, however, a significant decline in girls' positive attitudes was observed. Furthermore, girls were found to be drawn to themes perceived to have high social relevance, whereas boys were drawn to themes with high mechanical or practical relevance. The study concludes that it is important to balance the physics syllabus so that topics that 'have a natural appeal for girls as well as those preferred by boys are both included' (533).

Furthermore, most of the above studies are quantitative in nature, an important exception being Zohar (2003). He employed a mixed methods approach, where the statistical data are complemented by interviews with male and female students about the possible competitiveness in the physics classroom and how they value conceptual understanding. An example of a qualitative study is that by Stadler et al. (2000). Based on their observations of students working together, they claim that boys and girls have different ideas about what it means to understand physics.

Common to studies in this category is that they treat gender as a stable category and focus on the differences between the genders rather than on the variations within the genders. All in all, the studies in this category construct two different kinds of physics students: male students who are interested in physics for its own sake and enjoy practical exercises, and female students who want physics taught in a way they can relate to their own lives and who have lower self-confidence, particularly in relation to practical work.

Classroom practices

A second set of studies focus on classroom practices in differ-

ent ways. These studies typically either compare how male and female students respond to a certain form of teaching or discuss how to make the physics classroom more 'girl friendly'.

This category overlaps with the previous one, as several studies are designed to compare how male and female students respond to different forms of teaching. Gustafsson (2005) evaluated a distance course that was altered to include cooperative work and compared male and female students in terms of throughput and intrinsic motivation. Lorenzo et al. (2006) looked at whether the use of interactive teaching strategies in an introductory physics class could help to narrow the gender gap on the Force Concept Inventory. Pollock et al. (2007) did a follow-up of the Lorenzo et al. (2006) study in a different university context. Furthermore, several studies have examined how male and female students interact when working in small groups (Heller and Hollabaugh 1992; Tolmie and Howe 1993; Alexopoulou and Driver 1997; Ding and Harskamp 2006).

Most articles discussing how to make the physics classroom more 'girl friendly' are perhaps better characterized as teachers sharing of their experiences than as actual research studies. An early example of such an article is that of Pollack and Little (1973), who developed a 'women only' introductory course in physics with particular focus on laboratory work, offering academic and personal counselling for the students. Etkina et al. (1999) shared their experiences from a physics course developed for 'at risk students' (women and minorities), where elements such as qualitative mini-labs and interactive lectures were introduced. Williams (2006) describes how he developed a unit for teaching physics on the theme 'health and beauty', aimed in particular at less able female students. Robertson (2006) suggests teaching practices that

are aimed at ensuring a fair learning environment for both male and female students, such as single-sex grouping in the laboratory and interactive teaching styles. Different ways of teaching physics in a more gender-inclusive way are also discussed by Parker (2002), Norby (2000) and McCullough (2007). One research study on this theme is that by Laws et al. (1999). They evaluated the efficacy of new activity-based introductory physics curricula to explore whether such an approach could have the potential to close the gap between the number of men and women studying physics. An overview of early interventions at school level designed to make teaching more girl-friendly can be found in Taber (1991). A contemporary overview of teaching strategies that can 'help narrowing the gender gap' is provided by Lorenzo et al. (2006).

There are also projects aimed at encouraging female physics students through, for example, early research experiences and social opportunities (Schneider 2001) or through high school-college interactions (Light et al. 2002). Bazley et al. (2002) discussed the Internet as a possible means for allowing female physicists to meet each other. A comprehensive review of the reasons for underrepresentation of women in physics, including possible ways to encourage more women to study physics, such as mentors and programs designed to introduce young women to science, is given by McCullough (2002).

Typical studies in this category could be those of Lorenzo et al. (2006) and Pollock et al. (2007). By reviewing previous research on how to reduce the gender gap, Lorenzo et al. found that a common strategy suggested is that of active pedagogies. In their study, interactive methods that promote, for example, in-class interactions and that foster collaboration were applied to introductory university physics courses. The students' conceptual understanding was

then tested using the Force Concept Inventory (Hestenes et al. 1992). Compared to traditionally taught courses, it was found that the interactively taught courses yielded significantly increased understanding in both male and female students and, furthermore, reduced the gender gap. Pollock et al. (2007) carried out a study similar to that of Lorenzo et al., but with a different student population. The students in the Pollock et al. study both started and ended their course with notably lower scores on the conceptual survey than did the Lorenzo et al. students, and the difference in performance between male and female students was not reduced. They therefore concluded that interactive engagement may be necessary, but not sufficient, for reducing the gender gap.

In line with the studies in the previous category, these studies typically also construct male and female students as two different kinds of physics learners. The studies commonly have the aim of 'reducing the gender gap', whereas the studies in the previous category were instead exploring the gender gap.

Textbooks and tests

Several of the studies examining differences between male and female students do discuss pedagogical implications in terms of changing the context of examples, etcetera, to make them more gender inclusive. However, there are also studies that take the content of textbooks and tests as their starting point, examining them from a gender perspective. Larsen (1995) investigated the inclusion of female astronomers in astronomy textbooks. Walford (1981) and Whitely (1996) have analysed both gender balancing in physics textbooks in terms of illustrations and named scientist and gender stereotyping in illustrations and texts. Duit at el. (1992) outlines the design of a textbook with the purpose of mak-

ing physics more appealing to both girls and boys. Hoffman (2002) examined boys' and girls' interests and designed an intervention project in which new teaching material was developed to stimulate girls' interests.

McCullough (2001) examined the contexts of the questions in the Force Concept Inventory from a gender perspective, and Forster (2005) looked at the contexts of questions in an Australian entrance examination.

A typical example of a study in this category could be that of Whitley (1996). Here seven physics textbook were examined to determine the gender balance of the books in terms of illustrations and named scientists and possible gender stereotyping in illustrations and texts. It was found that all books included a greater number of male than female adults and mentioned a substantially greater number of male than female scientists. Some books, however, were found that avoided gender stereotypical illustrations, for example, by showing female computer users.

In summary, the studies in this category in various ways critically examine how physics is presented, in terms of, for example, what contexts are chosen for examples and what people that are chosen to represent the physicist.

Teachers' attitudes and knowledge

Most studies focus on the students, but Zohar and Bronstein (2005) examined physics teachers' knowledge about girls' low participation in physics and their views on the issue. They found that many physics teachers are not aware of girls' low participation rate in physics, or think that the gap is smaller than it actually is. Furthermore, about two-thirds of the interviewed teachers did not see girls' low participation in physics as a problem that requires

any action. They conclude that 'the data show that many of the reasons teachers gave are based on powerful gender stereotypes, expressing the view the men and women are born with different intellectual capabilities and that they are destined to different types of social and professional roles' (73).

Critical perspectives

Common to the studies presented above, with the possible exception of Zohar and Bronshtein (2005), is that they do not critically examine the meanings of science, but rather see physics as something relatively fixed. Critical perspectives on gender and the learning of physics are rare, but one example of such a study is that by Carlone (2004). She takes as her starting point recent literature on girls and school science, arguing that in order to engage girls in science, educational activities need to promote broader meanings of 'science' and 'scientist'. Her ethnographic study then examined the meanings of science and the kinds of science identities produced by students in a reform-based physics classroom (Active Physics). She found that the girls both resisted and accepted the active science learner identity. Carlone argues that when the girls resisted the active learner identity, it was because this identity threatened their highly valued 'good student identities', that is, their perception of what it meant to be a good student.

Despite the interactive and therefore presumably girl-friendly Active Physics curriculum, Carlone demonstrates how the curriculum enacted in the classroom she studied promoted meanings of science as difficult and hierarchical. This is well in line with Pollock et al.'s (2007) conclusion that interactive teaching approaches are not sufficient to promote female physics learners, but that what in fact needs to be studied is how a particular interactive

teaching approach is enacted by faculty and students. Summarizing, Carlone writes:

> The difficult and hierarchical nature of the enacted Active Physics curriculum implied science identities (e.g., someone who is "naturally" smart, has "raw talent", and is male) that were alienating, inaccessible, and/or uninteresting for girls. At the same time, these meanings did not challenge girls' taken-for-granted assumptions about who is "good" at science. Thus, most girls (even the successful ones) did not actively resist these celebrated science identities unless they perceived the practices as threatening to their grades or their "good student" identities (405).

In comparison with the studies presented above, Carlone views both gender and the learning of physics from quite a different perspective. First, learning is here viewed as identity formation, rather than acquisition of knowledge, and she gave agency to the learners, in that they are actively resisting and accepting different physics learner identities. Second, she critically examines a physics curriculum and the identities that are made possible by this curriculum.

In my own research, I work from the perspective of situated learning theory, thus also viewing learning as identity formation (Danielsson 2007, 2009; Danielsson and Linder 2009). My research interest is centred on the gendered experience of learning physics in the laboratory setting: how students in the context of laboratory work learn to become physicists. In order to explore this, I have developed a theoretical framework drawing on ideas from situated learning theory and post-structural gender theory. Furthermore, I critically examine the practice of university-based physics and what identities it is possible for students to construct in relation

to this practice. Empirically, I base work on semi-structured interviews with under-graduate and graduate students about their experiences of doing laboratory work in physics. The student narratives are then analysed using the theoretical framework, and in doing so I am able to look at gender as an active process and relate the dynamics of this process to the emerging physicist identities of the students.

Conclusions

In 1979, Physics Education dedicated a special issue to 'women and physics'. In this issue, Ormerod et al. (1979) reports on a study of male and female students' attitudes towards physics. Taylor (1979) analyses physics textbooks for possible sexist bias. Thompson (1979) provides a statistical background to the discussion on girls and physics in terms of the number of boys and girls taking and passing physics at school and university level. Finally, Harding (1979) discusses the sex differences in examination performance. As seen in this review, these 30-year-old articles could still be said to be quite representative of much of the later research in the area of gender and physics education.

The majority of studies on gender and physics education were found to be quantitative and dealing with students in primary and secondary education or introductory university courses. Missing are thus qualitative studies as well as studies dealing with students majoring in physics and with physics teachers. Further, most studies in this review were also found to be relatively a-theoretical in their application of a gender perspective, often taking gender as a synonym for sex. This puts a focus on the differences between men and women, rather than on the differences between men and between women. Further, most studies construct male and female

physics learners as two distinctly different groups, even though some studies do acknowledge the variations within the genders (see, for example, Zohar 2003). Implicitly or explicitly, the view of learning is one of learning as the acquisition of knowledge of physics subject matter, where students are seen as passive recipients of knowledge (with the exceptions of Carlone 2004 and Danielsson 2009). This is well in line with how research on the teaching and learning of physics has traditionally focused extensively on understanding and improving learning outcomes in terms of students' difficulties with physics content knowledge. Furthermore, principally as a result of cognitivist and individual constructivist perspectives, learning is most often understood, within physics education research, as an individual endeavour, with a focus on the individual student's sense-making or use of 'cognitive resources' (see, for example, Thacker 2003; Hammer et al. 2004; Redish 2004). Consequently, when such research employs a gender perspective, it should come as no surprise that it tends to see gender as a characteristic of the individual students, but without relating the students' learning to the gendered characteristics of physics as a discipline. Thus, I would argue that if we are to more fully understand the learning of physics, we need to shift our focus from the individual's performance to 'how students engage in science and how this is related to who they are and who they want to be' (Brickhouse, 2001: 286). This would then in turn also allow a shift from asking questions about how men and women do physics to how women and men are done in physics – how they constitute gendered identities along and against the gendered norms of physics.

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ELVIRA SCHEICH | West/South: Political Coordinates of Ecological Thinking in Feminism

The first and primary questions that arise when looking at the environment and ecology from a gender perspective have very little to do with nature, rather they are about women and society, and about politics. In particular, as will shown below, environmental problems and perspectives are directly related to how the political voices and agencies take shape within highly unbalanced power structures. This article focuses on the international women's movement, its main environmental themes and interventions, in order to explore the rift between feminism in the South, where environmental concerns are directly linked to questions of sustenance, and in the West, where ecological topics have largely disappeared from the agenda.

I observe these developments as a political scientist with an education in physics and an ongoing interest in science and science studies. In addition, the women's movement and gender studies in Germany have been the context of my research interests and have shaped them. This is where my story starts.

I. Local Beginnings

In October 1986, when the congress "Frauen und Ökologie: Gegen den Machbarkeitswahn" (Women and Ecology: Against the Delusions of Feasibility) was held, Cologne became the site of a milestone for the debates on gender and the environment. Three

days of plenary meetings and workshops brought together a broad range of scholars, politicians and activists from the new women's movement and gender research, the environmental movement, the movement against nuclear power and the Green Party (see Die GRÜNEN im Bundestag/AK Frauenpolitik 1987).

The questions concerning women and ecology were approached from different theoretical angles. Classical notions of "nature" and "woman" in philosophy, humanities, and the social sciences were under critical evaluation, showing how the links between gender, society and nature formed a cumulative system of domination. The ecofeminist perspective joined together women's reproductive work in the households of industrialized societies and their subsistence work in the third world countries (Mies et al. 1983). In a capitalist world economy that uses both as natural resources, the historicity of women's practices is denied. However, the tendency to generalize all women as victims of patriarchy and capitalism within this conceptual framework was debated as inadequate grounds for politically active women's studies (Thürmer-Rohr 1984).

In addition, the natural sciences had come under scrutiny and gender analysis was extended with respect to the cognitive structures and research practices in those fields. Since 1977, women in science and engineering have organized annual meetings (Götschel 2002), the journals *Wechselwirkung* (1981), *Feministische Studien* (1985) and *beiträge zur feministischen theorie und praxis* (1980 and 1983), issued special editions on women, gender, science and technology. The books of Carolyn Merchant (1980, 1987), Sandra Harding (1986, 1990) and Evelyn Fox Keller (1985, 1986) were translated into German in short succession and were adapted with great interest (Orland and Scheich 1993). The critique of gender

hierarchies in science and androcentric bias in scientific research, namely the combined images of women and nature in the rhetoric of domination, were seen as severe distortions of modern scientific objectivity and as substantial obstacles to coping with environmental problems.

On 26 April 1986, in the spring before the Cologne Congress, the Chernobyl reactor accident had occurred. The subsequent experience with the political authorities, the media and scientific institutions in dealing with the consequences of the disaster gave the debates in Cologne a distinct and urgent relevance. The lack of reliable information on radiation exposure, particularly through food, and the arbitrary setting of exposure limits had lead to a chaotic situation and profound uncertainty. Particularly how the concerns of parents and women with children had been downplayed caused widespread anger. During the summer, a growing movement for independent measurement stations had been formed, in which many groups of "Mothers Against Nuclear Energy" participated, often building on local feminist initiatives in the anti-nuclear movement, and making themselves lay-experts on the dangers of nuclear energy and radioactive isotopes.[1]

Already present at the Cologne Congress were the undercurrents of a heated and rather harsh debate within both feminist studies and feminist politics that reached its peak in the following months. In this controversy, the perspectives of a symbolic politics of motherhood and its radical rejection of the male techno-power system were set against an orientation towards professional equality (Gambaroff et al. 1986; Erler 1987). The cause of the quarrel was the draft for an anti-discrimination law that had been pre-

1 These groups often lasted for many years, developed an interest in renewable energy politics and built networks to help the children of Chernobyl (Neugebauer 2006).

sented in the German parliament in October by the Green Party (Gesetzesentwurf 1986:online). The criticism targeted an idea of emancipation in the draft that gave all weight to employment and privileged childless, independent, qualified woman and their adaptation to the men's world. With their mutually provocative labels of "tschernobyles Muttertier" (Chernobyl mother animal) versus "Aquarium der Karrierefrauen" (aquarium of career women), the diverse political ideals and outlooks soon turned into sharp tensions.

The internal controversies in West German feminism can be seen as characteristic of a society that has entered the age of ecology and can no longer ignore its environmental groundings, while the dominant structures of business, time and money remain unchanged. Because ecological concerns and activities continue to be mainly private affairs, they result in the feminization of environmental responsibility. The imaginary of the natural/feminine "other" is superseded by contrasting role models for women, different ways of life and associated goals of feminist politics (Schultz 1994).

In the following years, the majority of gender studies was turning away from eco-feminist questions. Two impacts heavily influenced this course of the debates: First, in the wake of the breakdown of the Eastern European socialist systems and with Germany's re-unification, environmental questions faded into the background. Second, with the linguistic turn and social constructivism reaching gender studies and becoming mainstream, body and language were now seen as the central axis of gender analysis.

II. Shifting Paradigms for Staying Alive

During the same years in the 1990s, the international women's movement achieved its profile as a political actor with respect to environmental politics in the changing global landscape of power. In order to seek political responses at the supranational level to the existing social, economic and ecological problems, which could no longer be dealt with on the national level, the United Nations provided the framework for the multilateral regimes of Global Governance through a double structure of the Intergovernmental Conferences and simultaneous forums of non-governmental organizations (NGOs). The forums served as the stage for international communication and the self-organization of civil society organizations, networks and movements with different approaches and from diverse political contexts (Commission on Global Governance 1995). Within this political field of action, the women's organizations and networks took advantage of the opportunity to intervene strategically and to place women's and gender issues on the agenda of multilateral negotiations.

In particular, the UNCED Conference 1992 in Rio, the so-called Earth Summit, became an important success for the international women's movement. The Rio Declaration stated clearly: "Women have a vital role in environmental management and development. Their full participation is therefore essential to achieve sustainable development" (Principle 20, online). Accordingly in Agenda 21 (online), the worldwide work programme for sustainable development and the largest of the five main documents signed in Rio, women were acknowledged as a "major group". The document as a whole presents the gender perspective as a cross-cutting issue in Agenda 21. Combining economical, social and environmental aspects of development concerning present and future generations,

the Rio Declaration introduced the concept of sustainable development[2] as a general mission for international politics.

When the UNCED conference affirmed women's crucial contributions to environmental management and sustainable development, the outcome was largely due to the extent of women's involvement in the preparatory process. WEDO (Women's Environment and Development Organization), an international umbrella organization founded in 1990, succeeded in transnational networking. Most importantly, WEDO directed these activities to the organization of the World Women's Congress for a Healthy Planet, held in Miami in 1991. More than 1,500 women from 83 countries came together, formulated and adopted Women's Action Agenda 21 (WAA 21, 1992), a blueprint for a healthy and peaceful planet in the 21st century.

Central to the statement was the notion of sustainable livelihood, comprising a decentralized and anti-universalist vision, centred on grassroots and with a bottom-up orientation. The livelihood approach is especially critical to what economist Naila Kabeer calls the 'iceberg' view of the economy, the fact that we only see the tip of what is actually going on by way of productive work:

2 The notion of a sustainable development that meets the needs of the present without compromising the ability of future generations to meet their own needs was coined and popularized in the 1987 report of the so-called Brundtland Commission (World Commission on Environment and Development 1987), named after its chairperson Gro Harlem Brundtland.

> Beyond the visible economy, however, there is a less visible, informal economy. Here goods and services are still marketed but go undocumented by official statistics. This is the informal economy. Beyond that is the subsistence economy, where goods and services are produced for own consumption. All these activities, in turn, rest on the unpaid work of reproduction and care in the household that ensures the production and productivity of the labour power that keeps the entire economy working. (Kabeer 2003: online, chapter 2)[3]

The illusion of gender-neutrality in macroeconomic analysis not only misapprehends distinctive women's work patterns in conceptual and practical terms, but it also fosters strategies for economic growth to increase the volume and value of market-oriented activities at the expense of non-market work.

In the WAA 21, the local foundations of life, survival, security and everyday experiences of women are the starting point for addressing questions of access and distribution. A basic question of survival or, as Vandana Shiva has put it, of "Staying alive" (Shiva 1989), is the preservation of biodiversity in lived local economies, where natural resources are utilized and preserved at the same time. Agriculture is still the primary livelihood for three-quarters of humanity, and in many cultures the women are responsible for the cultivation and development of seeds; in their gardens and small farms, they see to the improvement of varieties and manage the domestication of wild species. Especially poor rural women rely on the forests for their family meals. Besides wild fruits, they collect plants for medicinal use, materials for house building and for handicraft, as well as manure and organic pesticides for their pieces of land (UNEP 2004). Adaptation to the biological envi-

3 See picture 1: the pyramid of market, informal sector, private household, care.

ronment is as much a cultural activity as an economic one, and it is the material basis of cultural diversity. Skills and experience are crucial to maintaining biodiversity, however women's knowledge is often overlooked[4] or has become a commodity for sale, if not stolen by pharmaceutical and agricultural trusts claiming the intellectual property rights to indigenous species and the ways to use them (Comparative Perspectives Symposium: Bioprospecting/Biopiracy 2007).

With the prevailing tendency to see women's work as a "natural" aspect of their gender roles, the ways in which women are excluded from decision-making, deprived of property rights and constrained in access, use and control over natural resources remain invisible and unchanged (Rocheleau, Thomas-Slayter and Wangari 1996). Of principle concern in this respect are the rules of inheritance, which determine women's ownership of resources, and the rules of marriage, which determine women's domestic autonomy. En-gendering economics means that the structures of production and reproduction cannot be separated from social life in the family, kinship and community.

III. Strategies and Agencies

When international feminist policies were charted in a new way, environmental topics played a key role, because they were directly related to the lives of women of the South, especially in rural areas, to the threats of poverty and to questions of environmental justice. "We, the women of the South, ... believe that people have the right to sustainable livelihoods which encompass every aspect

4 The Convention on Biological Diversity (CBD) has acknowledged the contributions of women to global biodiversity. A Gender Action plan was not adopted before May 2008 (Conference of the Parties to the Convention on Biological Diversity 2008).

of human well being: material, spiritual, cultural, ecological and political." (quoted in Wichterich 2002:2f) The rights perspective, demanding women's recognition as legal subjects, their rights to social security and personal safety, embraces the economics of global inequalities, the ecology of sustainable livelihood and the strategic positioning of the feminist political subject.

Women activists and gender researchers from the South had started their intervention at the end of the United Nations Decade for Women: Equality, Development and Peace[5] in Nairobi in 1985. "Nairobi celebrated the arrival of Southern women's movements" (Agarwal 1996:87). They entered into the discourses with their own topics and visions and through their newly created network DAWN (Development Alternatives for Women for a New Era). They called for a revision of the dominant concept of development, in which the South has to catch up with the West and in which women were purely seen as victims and the most behind (DAWN 1985). Central to their analysis was the issue of power: between women and men, within particular societies and between nations and power blocs. DAWN foregrounded both the agency of women and the intertwining of existing gender relations with a diversity of other hierarchical structures. The self-organization of women, from the local to the international level, was seen as the key strategy of empowerment and directed towards broad social transformation (Braidotti, Charkiewicz, Häusler and Wieringa 1994).

Ideas about an alternative relationship between humans and nature and thus about new economical practices remained a strong point of reference within the international women's movements

5 The United Nations Development Fund for Women (UNIFEM) was founded in1976 and re-established in 1984 by the General Assembly as a separate and identifiable entity in autonomous association with the United Nations Development Programme (UNDP).

(Merchant 1995). The distinctions and conflicts that were characteristic of Western feminism were not adopted from the women's movement in the global South. The controversy about emancipatory ideals remained within the hegemonic conceptual framework of Western political arenas and resumed a privileged social position. Whereas seen from the South, environmental deterioration in the wake of structural adjustment programmes, nuclear armament, and new technologies brought forth the vital necessity to understand how the situations of women were entangled at the global level. Thus, the feminist "we" required a complex understanding allowing multiple alliances:

> The social relations of power include both conflict and cooperation and refer not only to power-over but also to power-with, where power may derive from solidarity as well as difference and solidarity may stem from identity, affinity or contingent coalitions around particular shared interests (Rocheleau 1999:22).

The awareness of pressing practical problems and dealing with them analytically and politically in thematical networks had become the starting point for redefining the commonalities as well as the grounds for transnational collective action.

DAWN had set the strategic perspective for the following years: networks of solidarity in a diversity of fields of action centred around human and women's rights beginning with a sustainable livelihood. In her report on the World Women's Conference in 1995 in Beijing, Bina Agarwal states:

> [A]mong women's groups there is a growing recognition of the importance of forging strategic links. One could say 'romantic sisterhood' is giving way to 'strategic sisterhood' for confronting the global crisis of economy and polity. (Agarwal 1996:88)

Networking in the fields of international politics took on the form of target-oriented transnational advocacy. "Mainstreaming" [6] and lobbying within the existing structures were key issues and activities to enhance women's participation in and influence on multilateral policy (Wichterich 2007).

IV. Critical Experiences

However, the World Summit in Johannesburg in 2002 showed that human and women's rights are precarious and up for renegotiation at any time. All human rights references were redeemed in the documents - only the right to health was defended with difficulty by the Women's Caucus. Although the international leadership of political institutions remained a predominantly male arena, women had entered the political class and become specialists among the civil society elite. In Johannesburg, their number was much larger than in Rio, whereas the global women's movement was by then barely perceptible – it had been "conferenced out" (Harcourt 2006:16). Scepticism had grown not only about UN conferences, but also about the official talk shops in general, because the participation of NGOs and women in multilateral politics seemed to end up in rather shallow results. Whereas political spaces for democratic activities had been opened up, the new political actors found themselves subtly aligned or simply added to the exist-

6 The 1995 women's world conference in Beijing institutionalized Gender Mainstreaming as the main feminist global project

ing balance of power without making an impact to change these structures.

The issues of women's rights and gender equality were integrated into the predominant development discourse; women were accepted as serious players and took up positions in the institutions involved in the UN processes. As gender experts, they committed their time and energy to amending documents and compiling manuals on gender mainstreaming. Within the global women's movement, the tendencies towards bureaucratic incrustation, as in most NGOs, could be narrowed down by the critical debates from within that were published in the reports, newsletters and webpages of DAWN, Isis-Manila, WIDE and SID's journal *Development* (Ruppert 2005).

How power and knowledge are processed through bureaucracies, negotiations and infinitesimal mechanisms has been analysed by Wendy Harcourt (2006). She looks into the microstrategies that induce paradigmatic shifts in the creation of dominant power knowledge, even when the goals are oppositional and transformative.

> The complex links between health, reproductive life cycles, the caring economy, the market economy, the environment and what was increasingly known by the end of this period as globalization, were repackaged by technical expertise into understandable development concerns. They were put through the UN machine of debate and policy making and came out as the issues that governments could agree to, but, it has to be said, rarely followed up. (Harcourt 2006:14)

To meet the requirements of a global discourse, simplifications had to be made that obliterated the enormous regional and cultural differences in the experiences of women.

According to Harcourt, crucial to the double-edged advances of the global women's movement are the representations of the female body in the operating biopower that changed the course of feminist political goals through the appropriation of feminist language:

> As productive bodies, women were redefined as the new workforce that needed management and care. The feminization of labour heralded them as the semi-skilled factory worker, the home worker and the informal worker whose industriousness was welcomed. ... as well as the main carers of the environment and culture in both urban and rural areas. (Harcourt 2006:14).

Through these images, a feminine model subject of individual empowerment and emancipation has been created that is adaptive to neoliberal market conditions and qualifies for the benefit of micro credits. The World Bank has initiated a Gender Action Plan under the headline "Gender equality as smart economics" (World Bank 2006)[7] and USAID comments on the key role of women in "effective development", stating that "(i)t is important to engage the untapped energies and abilities of people, especially poor women, if lasting progress is to be made" (USAID 2008:online).

Ewa Charkiewicz, like Harcourt an activist in the international

7 In his key note in celebration of International Women's Day in 2007, President Robert Zoellick stated: "In the midst of the financial crisis, women can be agents of change." See: http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTGENDER/0,,contentMDK:22118024~menuPK:336904~pagePK:64020865~piPK:149114~theSitePK:336868,00.html.

women's movement for many years, is also troubled by the resonances between feminist policies and neo-liberal governmentality. "Feminism and ecology as social critiques as well as social movements are situated in the larger power/resistance landscapes." (Charkiewicz 2004:online) In this context, she locates her rethinking of the visibility strategies developed by the international women's movement and asks by which hidden mechanisms the NGO networks of the global civil society themselves are taking part in the neo-liberal social and economic structural changes instead of their favoured self-image as the main opponent to the neo-liberal project. In contrast, she draws attention to the unsettling fact that the project of a global social-environmental contract and participatory societies as defined in Rio 1992 has never been implemented. Instead, during the course of the UN reporting process on Agenda 21, governments, NGOs and the UN acted under the presumption that its implementation was under way and thus established a narrative of "progressive" global social and environmental governance. "This talk about implementing a project that did not exist has far reaching political consequences as it obscured the operations of a neo-liberal global economy as the war on livelihoods" (Charkiewicz 2004:online).

The very same effect can be observed with respect to the Millennium Development Goals (MDGs) and the campaign for poverty reduction. Public attention has grown exponentially, and gender is stated as a cross-cutting theme, though major issues – sexuality, reproductive rights and health, and violence against women – are missing in the wording of the actual goals. They are discussed in connection with the process, but no clear indicators for women's empowerment exist, with the exception of better education for girls and reduced maternal mortality. What is more, even the in-

vestment in implementing the minimal gender goals is lacking in efforts. The MDG No. 7 "Ensure Environmental Sustainability" is not related to gender questions at all. The extensive reports for the Millennium Ecosystem Assessment (2005) on biodiversity, water, desertification and health focus on the material aspects of the relations between the social and the natural. Environment and nature are conceived as a critical system, which must be safeguarded from collapsing by fixing the maximum limits.

> [N]otions of sustainability are dominated by environmental issues, while the social dimensions are largely ignored. Issues of distribution and structural inequalities are not sufficiently considered, nor is the creation of viable social bonds, reliances and security, that is, practical social relationships beyond the market economy are undervalued in terms of their significance to sustainability. (Wichterich 2002:7, author's translation)

The synthesis report on "Ecosystems & Human Well-Being" (2005) attempts to chart the complex interactions between ecosystem services, constituents of well-being and drivers for change. When it comes to the cultural values and social co-operation involved in the maintenance of ecological systems, the descriptions become vague and the analysis grows weak. The broad range of knowledge and insights produced by the feminist critique of development and economics has not entered the predominant notion of sustainable development, and thus a reductionist understanding of nature/culture relations is maintained.

V. Alarming Changes

A specifically striking case is the United Nations Framework Convention on Climate Change (UNFCCC). Adopted in 1992 in Rio,

the convention came into effect two years later. Since 1995, annual conferences of the parties (COP) have been held negotiating on targets and rules in order to mitigate climate change and to adapt to its impacts. The UNFCCC Secretariat was established to support the international process. A binding commitment to reduce the world's CO_2 emissions was agreed upon in 1997 at COP3 in Kyoto and became operative in 2005. The Intergovernmental Panel on Climate Change (IPCC), established in 1988 by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP), constitutes the most important and influential scientific body in the climate change debate. Its assessment reports provide scientific data and analysis for the political negotiations, but fail to identify gender as a relevant category. Still, no decisions were taken concerning the integration of gender aspects into climate change debates and negotiations. That has not changed until very recently, and even now gender aspects stand askew to the strong orientation towards natural science-like factuality. "As the accepted authority on climate change, the IPCC 'position' can be viewed as the foundation on which climate change is treated as a gender-neutral issue" (Röhr 2006:9).

Debates on climate change continue to be driven by economical or technological viewpoints that lead to questionable effects of climate-related measures and instruments with regard to basic sustainability principles. Carbon trading, large hydro-projects and expansion of agro-fuels are counterproductive answers to Greenhouse Gas emissions; because they lead to deforestation, they contribute to reducing carbon storing capacities. Technocratic risk management and market-based conservation mechanisms don't benefit the majority of the world's poor, whose livelihoods are mostly outside the commercial sectors, and thereby they increase

related gender inequalities. In the North, lifestyle and political deliberations direct the involvement in climate and energy issues (Carlsson-Kanyama and Räty 2008). In their resistance to nuclear power, as in Europe after the Chernobyl nuclear disaster, women promoted renewable energy. They continued to be active in the anti-nuclear movement, but in the field of renewable energy technologies, the proportion of women has declined with the field's increasing professionalism (Röhr 2002).

Continued efforts to break away from the limitations of a technocratic orientation by using a creative and integrated approach that acknowledges the problems and contributions of women resulted in a significant achievement in Bali in 2007. A worldwide network of women, "gendercc – women for climate justice", was established and produced several position papers articulating the issues and entry points to climate change policy from a gender perspective. The statements point out three different aspects: (1) The responsibilities for CO_2 emissions are distributed in complex patterns, where gender is linked to production and decision-making, poverty and consumption. (2) The vulnerability of men and women is disparate, and especially with respect to exposure to disasters and health risks, the social gender roles make a difference; the resources and the work to adapt to the consequences of climate change are not equally distributed. (3) A comprehensive gender analysis of the climate protection instruments of the Framework Convention on Climate Change and the Kyoto Protocol is needed. The participation of women is hardly assessed, and for the industrialized countries, no gender analysis is available at all.

This lack of gender knowledge is related to imbalances in the gender composition of the UNFCCC and Kyoto process. Here, the

organization is different from other corresponding UN processes; there are no major groups, and active participation of observer organizations, such as the possibility to speak and to participate in workshops, is limited. In general, women are underrepresented; whereas the lobby organizations of businesses and industries are almost completely male[8], women often play a key role in the environmental NGOs. In particular, women's leadership in government delegations or as head negotiators became decisive in shaping the Kyoto protocol through their commitment to integrating the delegations from developing countries into the negotiating process (Villagrassa 2002). Despite this, no gender aspects at all were on the agenda until Marrakesch 2001, when women from Samoa pushed for a draft decision on improving the participation of women among the representatives. Two years later, Milan became the site of the event "Promoting Gender Equality, Providing Energy Solutions, Preventing Climate Change", organized by the Swedish environmental minister, Lena Sommestad, together with her colleagues from the Network of Women Ministers of the Environment. The first gender perspective on the production and consumption of energy had been introduced the year before in New Delhi, and again the initiative came from the South where a new organization, ENERGIA, had been formed. Not before 2005 did gender questions enter the plenary discussion in Montreal.[9]

VI. Changing Fields of Action

Parallel to these efforts, the strategies of ecological modernization are being intensified to make neo-liberal globalization com-

8 Gender is not the only power imbalance in play: "the vast majority of representatives are from the USA and less than 5% are from developing countries" (Röhr 2006:6).

9 See picture 2: Minu Hemmati from LIFE/WECF on the podium at COP 11 in Montreal.

patible with the need for sustainability. The global neo-liberal economy has expanded to a world system, in which institutionalizing the global as the domain of governance became requisite and the earth's biosphere is increasingly approached as a controllable ecosystem. The linkages between the discourse of sustainable development and the "simulacrum of participatory democracy" (Charkiewicz 2004:online) demand a deepened analysis if we are to grasp the hidden organization of power. The growing disparities that come with biopiracy, emissions trading, and the recent reconsideration of nuclear energy in the context of intensified neo-liberal globalization demand the transformative potential of social critique and political movements.

Women's organizations are still present at the UN institutions; however, the energy of the women's movements began to join forces with the campaign against neo-liberal globalization at the World Social Forum (WSF). The mass protests against the WTO ministerial in Seattle in December 1999 ended the decade of political negotiations and compromise and marked a shift in policy style and orientation, in which open public spaces regained a greater role for political controversies. The World March of Women, starting in 2000, has become an extensive grass-roots movement (Dufour and Giraud 2007). Since 2003, regular transnational discussions among feminist networks and organizations in the context of the WSF are organized by the Feminist Dialogue (FD). This exchange of political visions, analyses and actions aims at feminist politics and theoretical reflections "informed by the contradictions within and between the lives of women living in late global capitalism" (Bracke 2005:99).

Thus, the FD contributes to an understanding of feminist movements as fluid, dispersed, and full of diversities and contradictions. The *Methodology Note* defines the goal as "bringing conflicts, dilemmas and experiences of feminists in the context of globalisation, fundamentalisms, and militarism to the surface" (FD 2007:online). The participatory and open-ended dialogue seeks to use the contrasts of regional experiences as a resource, not to produce unified statements, but instead to find the points of resonance within internal diversities. As Amanda Gouws points out: "It is important to understand that the FD is a process and not just an event" (2007:29).

The key issue of debate continues to be how the global women's movements, operating in the international arena, relate to the "place-based" concerns of women in their local communities, concerns such as livelihoods and rights, safety and health. Moreover, how can women at different levels of political engagement connect their activities across cultural, geopolitical, ideological, racial and ethnic divides?

> There are rifts between women of the North and of the South. There are divisions among older feminists and younger feminists. There are tensions between black feminists and white feminists, and differences of opinion among working class women and elite women, this is as old as the movement itself (Sisonke Mismang, quoted in Harcourt 2006:21).

The FD's answer to these problems is dynamic in principle, spatio-temporally situated and opens up these confines, thus, they carry forward DAWN's strategic approach to conceptualizing feminist solidarity. The attempts at dialogue, reflection and deliberation that reach beyond the local contexts are amended with the insight

that networking and mobilizing around global events are also limited in their specific way. "This is where a more nuanced sense of politics is required." (Harcourt 2006:22)

The multidimensional identities of "polyversal" feminism challenge any claim about a privileged road to emancipation and empowerment. Yet the response from Western feminism is weak. In the transnational debates, North American or European voices that articulate the problems caused by neo-liberal globalization in their countries are largely absent (Charkiewicz 2004).

VII. Bringing Messages Home

In Western gender studies, ecofeminism has become a prime target of what Bonnie Mann calls "emphatic anti-essentialism" (2005). As she observes, "the accusation 'essentialist!' has come to exercise a disciplinary force among feminists ... Particularly, the usual ways that feminists have talked about our relationship to the earth and nature have been discredited." (Mann 2005:47) In her pointed essay, Mann asks what counts as "good" feminist theory when the coverage of "essentialism" is constantly extended, and what are the prohibited territories? One of her answers is: "Inquiries into any common condition that women might share, such as our relationship to a planet suffering the strains of ecological devastation, for example, are foreclosed." (Mann 2005:52) Accordingly, the disappearance of ecological-feminist concerns from the theoretical agenda was accompanied by the de-politicization of the gender discourse. Gender knowledge then remains purely negative in stating the contingencies and theory merely repeats the experience of "world alienation" (Mann 2005).

The category of nature has been the object of a deconstructive move in gender studies that focussed on the simultaneous

production of identities in body and language. Based on a strictly relational concept of gender, any naturalization of gender differences is rejected. Gender is seen as "discursive/cultural means" (Butler 1990:10) for the production of pre-discursive facts such as nature, biology, body, and matter. The natural origin, in which the heterosexual matrix anchors its normative power, is constituted at the moment of separation and naming, in which the mutual creation of identity and alterity in the processes of "othering" starts to operate.

> What I would propose in place of these conceptions of construction is a return to the notion of matter, not as site or surface, but as a process of materialization that stabilizes over time to produce the effect of boundary, fixity, and surface (Butler 1993:9).

As a critical orientation to these kinds of problems, Donna Haraway has introduced the cyborg as a leading figure in gender studies. Her analysis aims at the production of nature, biology, materials (including and beyond language) and the special part played by the sciences and technology. In a series of studies, she shows how contemporary technosciences constantly undermine the categorical separation of nature and society, breaking them down in their practical activities. By looking at the knots of power and knowledge, matter and meaning, technology and biology, nature and culture, unexpected constellations and shifting meanings occur, bringing new things into existence, like

> [t]he ecosystem as an object that could have only come into being in the context of resource managements, the tracking of energies through trophic layers, the tagging apparatuses made possible by the Savannah River Nuclear facilities, and the emergence of wartime inter-disciplinarities in cybernetics, nuclear chemistry and systems theories (Haraway 2006:136).

The multiple intersections of gender dualism with the categories of nature and culture call for a combination of analytical resources from critical social theory as well as from post-structuralism (Scheich 1996). Butler and Haraway have made the most fruitful and influential contributions to gender theory since around 1990. Their analytical orientations are complementary in charting the categorical field of gender theory between the poles of nature and culture, in which both theoretical angles supported critical perception through their fascination with boundaries and especially with the crossing of boundaries. However, the radical questioning of women's political identity grounded in the biology of their bodies gave way to a tendency in the gender discourse simply to avoid "nature" in any material sense altogether. The advantages gained through critiques of a natural-bodily substance, the sex/gender distinction and related dichotomies are turned upside down when any feminist approach focused on ecological topics is suspected of essentialism and seen as opposed to ideas such as cyborg-feminism.

The juxtaposition signals an ignorance of the developments that have taken place since the late 1980s, both the theoretical explorations of nature/culture boundaries and the political crafting of a polyversal feminist agency. The mainstream of academic gender studies is not engaged in a dialogue with the international women's movements. Particularly worrying are disturbing paral-

lels with the global cleavage between feminism in the West and in the South. The specific way of fixating on the nature/culture distinction in the anti-essentialist turn against ecological feminism further implies barriers against other culturally bound notions and practices. Because: What if the social relationship with nature is embedded in a totally different reference system of ideas and experiences, where no formation of surface and no concept of nature beyond society exist, where distinctions of that kind are not meaningful and thus are not the starting point for critical thought (Strathern 1980)?

Several interventions have recently been made to develop a theoretical framework that integrates post-structuralist insights into an ecological perspective. Most notably, a move away from nature in the singular form, existing outside history and human context, has been made towards the plurality and diversity of natures.

> As much as identities, natures can be thought of as hybrid and multiform, changing in character from place to place and from one set of practices to another. In fact, individuals and collectives are compelled today to hold various natures in tension. (Escobar 1999:2)

As a consequence, for an international research field like gender studies, where basic theoretical concepts are transferred between languages and cultures, the translation of "nature" is not only a question of words. However, very little attention has hitherto been given to the temporal and spatial variability in perceptions of nature. The transformations that accompany every process of translation and the transference of "nature" from one cultural framework to another are still waiting to be properly recognized.

Only recently have the grounds for such investigations been established.

Closely linked with both the notion of "polyversal feminism" and the discussion about multiple natures are the programmatic ideas of feminist political ecology. The diverse and distinctive locations, in which nature regimes and knowledge regimes are interwoven, become the starting point for understanding the actual relevant gender categories in the "Politics of Place" (Harcourt and Escobar 2005). The goal is to develop a comprehensive picture of how work and environment in addition to body and language are integrated into local-global patterns. The conceptual starting point demands an epistemological shift to "weaving chains of explanation into webs of relationships and situated science" (Rocheleau 2008:716; see also Code 2006 and 2008).

Concurrently, a re-thinking of ecofeminism[10] has begun that maintains the claims to change social relationships to nature as a feminist political goal (Sandilands 1999 and Alaimo 2000). By drawing on Hannah Arendt's perception of world-making, the combined political and material aspects of environmental activities are foregrounded. The critique of "nature" as a category of distinction, hierarchization and reification opens the space for counter-meanings and active reinterpretations that avoid the simple reversal of existing ascriptions, like women and nature. Rather the situatedness and performativity of the relations with nature become the deliberate object of study. In this framework, the critique of the social relations of care practices and an orientation towards questions of citizenship constitute the gender perspective of environmental politics. The range of research topics spans local

10 See e.g. Warren 1996, Plumwood 2002 or for an anthology with mixed approaches, see Salleh 2009.

policy studies, such as those on the activities of women in Berlin (Buchholz 2004) or Toronto (MacGregor 2006), as well as the re-design of environmental historiography in order to reconsider predominant ideas about wildlife, wilderness and nature in relation to differently gendered experiences (Sturgeon 1996; Bulbeck 2005; Hesse et al. 2005).

All these projects are part of a renewal of "material feminisms" (Alaimo and Hekman 2008) and contribute to efforts to go beyond post-structuralist critique while building on its insights. The conceptual move from the universal nature/culture difference to the idea of multiple natures allows us to grasp the intersectionality of gender with other categories of social inequality in its material dimensions, namely as a physical reality, which exists at specific places entangled in linkages and networks that produce the conditions for transformation. At this point the crucial question becomes: How can we realize these transformative potentials within the sciences and make sustainable science projects possible?

Gender projects within environmental studies directed at very recent problems must deal with the productive role of science in its powerful interaction with economics, in particular the natural sciences and technological disciplines, which are active in shaping material realities and creating the shared world we live in. As became obvious in the case of climate change, the predominant scientific approaches are not only lacking in gender facts and gender expertise. Moreover, in relation to the present knowledge about the mechanisms of climate change and the design of adaptive measures, the ongoing co-production of nature and society is still interwoven with gender hierarchies in such a way that leads to the reciprocal stabilization of ignorance and factuality. The gendered dissociations of knowledge from great areas of human practice af-

fect the notion of sustainability at its core, leaving the implementation of normative and emancipatory objectives behind. Instead, how responsibility and justice are envisioned in provision-making for the future has to be analysed critically as a inherent part of knowledge production.

A sustainable science project is thus aware of the fact that it is a component of the subject under study. This point of view requires a conceptual move from observation to participation, from structures to processes, from substances to relations, from things to functions, from identity to difference. Typical of the conceptual shift is the preference for theories, which deal with the design of border regimes and the simultaneity of constitution and exclusion, and of models, which integrate the processes of perception as an active element in the constitution of the knowledge object. In gender studies, this orientation has been conceived mainly in connection with critical social theory. However, such a transition, from a logic of identity to a logic of relations and differences, has been achieved in various disciplines to varying degrees.

With respect to environmental topics, such a theoretical orientation can serve as the starting point for further research, in which the question still has to be pursued of how negations in the social life-nexus with natures can be made visible and overcome. Here, the analytical tools of gender impact assessment that systematically integrate the dimensions of work, body, and empowerment allow us to identify gender issues in classical as well as in new research approaches as life cycle assessment, exposure modelling, or the science of resilience to objective conditions. In the context of socio-ecological research, this objective corresponds with a notion of transdisciplinarity as a process combining research, decision-making and shaping interventions into the material world in-

formed by the participation of heterogeneous actor groups, modes of reciprocal and recursive learning as well as theoretical work on science (Schäfer, Schultz and Wendorf 2006). Transdisciplinary research in sustainable science projects aims at making changes within the sciences themselves by developing democratic methods for generating knowledge that avoid the simulacrum of problem solutions.

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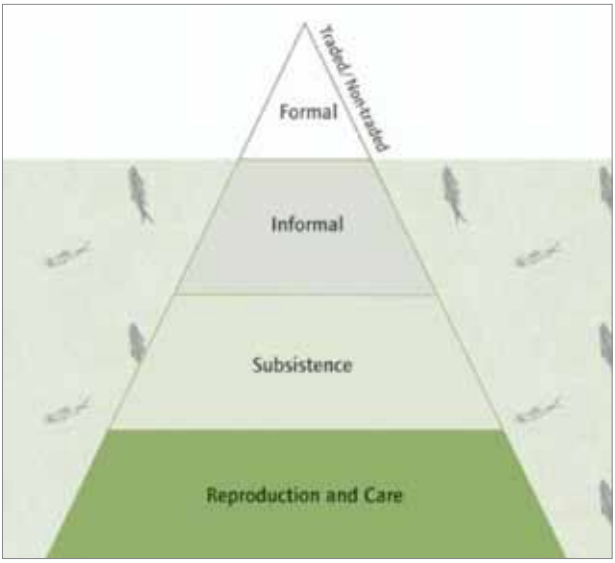
Organizations:

DAWN – Development Alternatives with Women for a New Era. http://www.dawnnet.org/
ENERGIA – International Network on Gender and Sustainable Energy. http://www.energia.org/
FD – Feminist Dialogues. http://feministdialogues.isiswomen.org/
genanet - Leitstelle Gender, Umwelt, Nachhaltigkeit. http://www.genanet.de/
gendercc – Platform for Information, Knowledge, and Networking on Gender and Climate Change. http://www.gendercc.net/metanavigation/home.html
Isis International-Manila. http://www.isiswomen.org/
SID – Sociey for International Development. www.sidint.org/development
UNIFEM – United Nations Development Fund for Women. http://www.unifem.org/
WEDO – Women's Environment & Development Organization. http://www.wedo.org/
WIDE – Women In Development Europe. www.wide-network.org
World March of Women. http://www.marchemondiale.org/index_html/en

Pictures:



Picture 1

Picture 2

STAFFAN BERGWIK | Networks, marginality and fractured identities: The history of women in science and feminist science studies

This essay stems from my uneasiness about working as an interdisciplinary scholar.[1] On the one hand, as a historian of science, I work in a discipline that over the past twenty years has been increasingly specialized and oriented towards microhistorical case studies (Kaiser 2005: 244–245). Historians of science work under mottoes of "thick description" and "micro-studies". They have narrowly defined topics and cultivate a "bottom-heavy apparatus of footnotes", which makes them less amenable to generalizations; they are "like other historians: guardians of the particular, sceptics about the universal" (Daston 2008: 166–167). On the other hand I consider myself part of the research field *Science and Technology Studies*, STS. Albeit neighbouring (and partly overlapping) the history of science, STS research is often marked by different assumptions, claims and styles. It is characterized by elaborate theoretical discussions and far-reaching ambitions of generalizing the understanding of science.[2] These generalizing tendencies and

1 I wish to thank Petra Jonvallen, Francis Lee and Mikaela Sundberg for crucial help with this piece. I am also grateful to the members of the "Internal seminar" at the Centre for Gender Research at Uppsala University for fruitful comments on drafts of the article.

2 STS brings together social, cultural, political and economic perspectives in the study of science and technology, see Biagioli 1999, Golinski 1998, Jasanoff 1995, Sismondo 2004, Star 1995.

theoretical discussions have had but a shallow impact on the history of science.

In a broad sense, the tension that characterizes my work is a long-standing disciplinary opposition between the different meanings, means and goals of doing historical and sociological research (Berner 1999: ch. 6) Historians make interpretations close to the empirical material and put great emphasis on the historical context. Conversely, sociologists are more interested in saying something general about society using concepts transcending history. Typically, the social scientist uses historical examples to support overarching theoretical models of society.[3]

In my current research, I explore women as "outsiders within" Swedish science in the early twentieth century.[4] This work starts at the intersection between two related branches of history of science and STS: *the history of women in science*, on the one hand, and *feminist science studies*, on the other.[5] There is a striking lack of critical dialogue between these areas of research. In overviews of research on Gender and Science, historical studies of women are often portrayed as an origin – as the first step in a "contemporary feminist scholarship on the natural sciences". During the 1980s, this first move was replaced by a broader discussion, using "gender" as an analytical category, which "opened an entirely new window on the nature of scientific inquiry" (Keller and Longino 1996:

3 Together with six other Swedish historians of science, I have discussed the relationship between empirical history of science and theoretical STS research more broadly. See Beckman et al. 2008.

4 This research is being carried out as part of the project "On the outskirts of science: Women as outsiders within early twentieth century Swedish science" financed by the Swedish Research Council.

5 Feminist science studies are often portrayed as a branch of STS, Lederman and Bartsch 2001: 2, Sismondo 2004.

2).[6] Eventually, as an effect of these theoretical innovations, the broad area of research called feminist science studies was formed.

Albeit crudely portrayed here, I suggest that this feminist 'lineage' has had negative effects on the scope, future direction and importance of doing research on the history of women in science. This research is surprisingly disconnected from cutting edge feminist research on the natural sciences. An important reason is the divergences in style, which repeat the differences between history of science and STS. The history of women in science has a highly historical and empirical character, while feminist science studies discuss the contemporary conditions using highly elaborated theoretical tools.

My aim here, against this backdrop, is to suggest ways of fuelling the history of women in science by reconnecting it with feminist science studies. The former needs to revisit some of its fundamental assumptions, and theoretical discussions in feminist science studies offer tools to do so. Some of the vibrant theoretical discussions in feminist science studies could, and should, be transported into the history of women in science in order to give it more "epistemic bite" (Kaiser 2005: 250).

The only viable way for me to do this is to ground the discussion in my own research and some theoretical tools useful to me. Consequently, I will discuss three topics that are recurring in my own work on the power structures of Swedish science in the early twentieth century and women's position in those structures. First, I will address *power structures* in the *networks* of science, discussing how feminist science studies, and STS more broadly, challenge established conceptualizations of power. Second, I will discuss *marginality and the peripheries of scientific communities*, in-

6 See also Berner 2004.

dicating ways of understanding the complex nature of positions that the majority of women in science historically have upheld. Third, I turn to *identities*, displaying how feminist science studies have discussed *fractured and unstable* identities. I do not claim to do justice to all aspects of feminist science studies.[7] Instead I will focus on parts of it closely related to core STS research, mainly actor-network theory, ANT.

Although I am suggesting that a greater interest in the theoretical tools discussed in these areas of feminist science studies can pave the way for historians to write a more powerful history of women in science, I am not advocating one-way traffic. Towards the end of the article, I will suggest that the local, and empirically rich, histories of women in science can add to the theoretical discussions in feminist science studies and STS. The history of women in science should keep on doing in depth case studies but also – and as an effect – address more theoretical issues in feminist discourse.

Power structures: Institutions, networks, and durability

In early twentieth century Sweden, women in science were held back by national laws, institutional hierarchies and academic mores. Barriers and power structures were abundant in ways similar to other historical, national and academic contexts. Anyone interested in the history of women in science will thus have to consider how power operates in the natural sciences.

In most Western countries, current debates on women in academia focus on gendered boundaries through well-established

7 For more extended overviews of the theoretical, methodological and thematical diversity in feminist science studies, see e.g. Berner 2004: 11, Keller 2001, Lederman and Bartsch 2001, Mayberry et al., 2001b, Wyer 2001.

metaphors. Repeated models like the "leaky pipeline" and "glass ceiling" are utilized to highlight difficulties for women (Berner 2004: 26; Husu 2001: 175; Schiebinger 1999). Albeit useful in political discussions, these metaphors are less well suited to historical explorations. They tend to be static and descriptive, one-sidedly giving attention to exclusions and assigning a passive role to women. Furthermore, they view science as a clear-cut, institutional endeavour with rigid borders between inside and outside (Husu 2001: 176–179). Historical research on women in science has offered empirically rich examples of how power structures work, adding complexity and context to the simplified metaphors. Historians have teased out "systematic patterns" of marginalization, and ideological and social circumstances excluding women from scientific communities have been brought to the fore.[8]

Professional science has been given particular interest, and women's histories have been used as a vehicle to transform the understanding of professionalization. Historical explorations of how scientists drew up standards for their activities have suggested that modern academic institutions obstructed women. Across Western Europe and the U.S., professional barriers (e.g. standardized training) were erected, hampering women's participation. Universities allowed women to pursue degrees, but the openness for studying was matched by limits set on possibilities for employment in academia. Historical studies have produced insights into backlashes and non-linear changes in scientific institutions, enhancing our understanding of formal barriers but also of informal structures working against women.[9]

8 Berner 2004: 19 and ch. 2, Kass-Simon 1990, Keller 1995: 83, Kohlstedt 1995: 39–40, Kohlstedt 1999: 1, Kohlstedt and Longino 1997: 3–4. Lederman and Bartsch 2001, Markusson Winkvist 2003, Rossiter 1995: xv and xvii.

9 Berner 2004: 21–25, Creese 1991: 276–278, Kohlstedt 1995: 43, Kohlstedt 1999, Rossiter 1982, Rossiter 1995, Schiebinger 1999: ch. 1.

The importance of this work notwithstanding, a large body of work in STS has moved the explorations of science beyond "institutions", with the argument that the practices and cultures of the sciences do not easily map onto institutional boundaries. Other ways of conceptualizing scientific work and knowledge production have been launched, e.g. "networks", "subcultures" and "social groups" (Galison and Stump 1996; Golinski 1998; Hess 1997b; Jasanoff 2004).

Here I will focus on *network* because it is a way of more systematically indicating the permeable boundaries of academic science. As an analytical concept, network renders the institutional boundaries of science problematic. To date, it is one of the most debated approaches in STS. To some extent, historians have used network approaches to study collaborations involving women. The empirical focus of this research has included the International Federation of University Women, but also clubs, correspondence, and mentor chains.[10] These networks functioned as resources in political strategies to advance the position of women in science (Kohlstedt 1987). They also enabled women to move scientific approaches into new disciplines not laden with a long masculine tradition, such as home economics, public health and education (Jones 1990; Kass-Simon 1990: xivf.; Kohlstedt 1995: 48-49).[11]

However, the elaborate theoretical discussions in STS about networks have not had an impact on historical research on women in science. Drawing more explicitly on network approaches in STS

10 Lykknes et al. 2004a: 132–136, Lykknes et al. 2004b: 584, Rayner-Canham and Rayner-Canham 1997: 18–24, Rossiter 1982, Scheich 1997.

11 An important elaboration of the network approach is Maria Rentetzi's work on radium research in 20th century Vienna. She studies partnerships and collaborations by highlighting radium as a material commodity. She argues that radium as a trafficking material defined individual and institutional partnerships, and she shows how the material enforced women's networks and strengthened their position among radioactivists: Rentetzi 2007: ch. 1 and 6.

could benefit the historical research on women in science, in particular through the ways that power has been seen as an outcome of networks. This is a crucial argument in actor-network theory. Network, in the ANT version, is a way of accounting for how allies are enrolled, and made to accept and support a scientific fact. Broadly speaking, it is a sociology of translation with an interest in analytically binding together actors, and constellations of actors, that at first glance seem to be separate. It investigates how different phenomena "enter into proximity with otherwise distant events, regions and ideas" (Brown and Capdevila 1999: 28; Law 1999: 9). The network metaphor in ANT means exploring transformations, translations and transductions, not possible to capture with other approaches in social theory.[12]

Power is an important analytical topic arising out of ANT as the theory was elaborated in the 1980s. Furthermore, it is a key issue in the history of women in science and feminist science studies alike. While so many things about the natural sciences change rapidly over time – its equipment, settings, financing – the gendered character of science shows a striking stability. How can this hegemony be maintained over time? How can we explain its *durability*?

ANT considers power a consequence rather than a source of action – it "may be used as an effect, but never as a cause" (Latour 1986: 256). An actor-network theorist refrains from assuming that power emanates from institutional structures. Instead, power relations are understood in an interactionist perspective, as the outcome of established and durable networks, built over time. According to ANT theorist Bruno Latour, power is not something that can be stored or possessed. It is rather the outcome of a sta-

12 Callon 1995: 52, Hess 1997b: 109, Latour 1987, Latour 1999: 15, Wormbs 2008

bilization occurring in a successful network, not something that precedes the network building. Thus, the actor who dominates other actors cannot be described as doing this because of his/her power.[13]

Through numerous empirical examples, the history of women in science has shown female actors living and acting in the power-laden systems of science. The conceptualization of power in ANT could inspire new understandings of how male hegemony has been exercised. ANT offers a thought-provoking switching of causalities, and as a result it presents historical research on women in science with a challenge to rethink power as an analytical category. My own research draws on network approaches to explore how women in Swedish science were partly part of science through collaborations (as wives, assistants or friends) with male scientists. In particular, I am interested in how network connections created a gendered position for women. In this instance, the analytical category of network offers ways of deepening our understanding of power structures. Indeed, it might be argued that Swedish university policies in the late nineteenth and early twentieth century rested on a wide-ranging and durable network that kept women from moving into academic science. The network consisted of heterogeneous actors and "actants" (non-human actors), among them university professors explaining the "male" characteristics of doing science, medical and anatomical models of the female body, the Swedish constitution stipulating that only Swedish "men" were allowed to work at the universities etc. In the explanatory framework of ANT, this network is vast but stable and because of its stability able to exercise power.

13 Bijker and Law 1992, Latour 1986, Latour 2005, Law 1986: 15–18, Singleton 1996: 457–461.

This is a very sketchy example of how the historical study of women in science could engage theoretical discussions in STS. There are problems involved in attempting such a discussion, however. ANT radically questions crucial historical categories like institution and community, replacing them with network. In the final section, I will return to some of the tensions between the ANT approach and historical sensibilities. Furthermore I will suggest how historical studies of women in science, through their detailed empirical approach, could engage in discussions about how we can understand science in STS.

Marginalities in science

Historical studies of women in science have displayed women's "narrow social niches" and their hidden work as assistants, collectors and teachers outside the hegemonic definitions of science. This research addresses questions about work in the "margins" without possibilities of gaining powerful positions.[14] Through these interests, the history of women in science has moved into marginal contexts that the bulk of STS as well as the history of science has not emphasized (Sedeno 2001). Women in the history of the natural sciences have typically retained a position in the 'outer circles', being assigned a "secondary demarcation" and a "feminine subsphere" within science (Keller 1991: 229; Zuckerman et al. 1991:12).

But what do these peripheral positions entail? How can we understand marginality and peripheries of science? In my own work, I have addressed these questions in a study of Eva von Bahr, who was Sweden's first female assistant professor in experimental

14 Kass-Simon 1990, Kohlstedt 1995: 46, Outram and Abir-Am 1987, Pycior et al. 1995, Rossiter 1982: ch. 3, Wennerholm 2008.

physics. As such she struggled with the academic power structures discussed above. She got her doctoral degree from the University of Uppsala in 1908. Subsequently she worked with teaching and research in Uppsala and Berlin up until 1914, when she gave up her work in academic science and got a position as a teacher at a "folk high school" (*Folkhögskola*). In my work, I have drawn on theoretical discussions in feminist science studies, describing von Bahr as an "outsider within" academic experimental physics. I argue that von Bahr was simultaneously an outsider and an insider, hence the concept of outsider within (Wennerholm 2009).[15] This perspective stems from feminist discussions, partly growing out of actor-network theory. It addresses the complexities inherent in marginality and highlights crucial processes of belonging and yet not belonging – of being peripheral in the networks that make up science.

As important as they are in balancing the historical canon of science, historical explorations of women as peripheral in science run the risk of becoming overly static and black boxing the centres of science. Male communities of science tend to be portrayed as coherent and unwilling to harbour differences. On the contrary, it might be argued that everybody in a community has difficulties fitting in. Lived experience rarely matches coherent community norms. No one is 'pure', and in that sense the whole idea of margins (and as a consequences a centre) is somewhat problematic (Bowker and Star 1999: 300–303). One way to avoid overly static centre-periphery models is to pose questions about the history of scientific insiders. What does it take to be an insider, and is there

15 On the concept of "outsider within", see Collins 1986, Collins 1989, Star 1995.

indeed a position as such that is stable over time (what happens for instance to the esteemed scientist passing the peak of his career)?[16]

Research on the history of women in science has certainly used a "vocabulary of marginality", portraying women as being on "the periphery, the edge, the outside" (Kohlstedt 1995: 45). But this work could be enhanced by engaging some theoretical notions of permeable boundaries between inside/outside. Traditionally, the sociological term marginality signifies persons belonging to more than one community. The marginal individual has a "double vision" that stems from having several different identities to negotiate. This entails a peripheral position; the marginal actor is a stranger that stays for a while, simultaneously belonging and not belonging (Bowker and Star 1999: 301-302; Star 1995). From these broad sociological conceptualizations, feminist science studies scholars like Susan Leigh Star have augmented our comprehension of marginality.

Scholars like Star work "after ANT", i.e. elaborating the theory after the 1980s (Law and Hassard 1999). These feminists have argued that ANT has an excessive interest in actors at the centre of networks, typically entrepreneurs who have the possibility of enrolling others. ANT follows the actors (a vital methodological vantage point in the theory), but only the actors that have the power to implement their perspective (Asdal et al. 2001: 37; Star 1991). Especially ANT studies carried out in the 1980s highlight how networks get assembled and the struggles between "managerialist" actors to wind up at the centre (Law 1999; Law and Callon 1992).

The feminist perspective in contrast tries to account for peripheral actors. It emphasizes a multitude of positions in networks

16 This resonates with arguments about the dangers of conflating "women" with "gender" and calls for a symmetrical analysis of gender, e.g. by discussing masculinity as gender; see Keller, 1995: 84.

and extends the network approach by starting with the "monsters" that do not "neatly fit the standards of [...] smoothly working networks" (Haraway 1997: 34; Prins 1995: 363; Star 1991: e.g. 29 and 42). According to the critics, ANT levels the differences between actors, leaving the marginalized voices and experiences concealed. Therefore, feminists like Leigh Star argue that it is vital to put the "exiled aspects" of scientific work back into the analysis and investigate networks from the position of actors who are left out or spoken for by others (Singleton 1996: 458; Star 1995: 1–2).

This feminist network approach destabilizes the centre-periphery model. As Leigh Star has argued, it is vital to look at the consequences of network building for all the actors involved. Indeed, in thinking less statically about margins and centres, or outsiders and insiders, we are left without a centre and margin. Instead there is a multitude of viewpoints – we are left with a much more complex view of scientific networks. This dialogue between feminist science studies and ANT has developed into a broader interest in heterogeneity and complexity. Starting with the problem of how simple orders bracket out too much of reality, complexity is seen as a way of accounting for multiple orders working at the same time. Again, the point is to start in a multitude of places in order to explore different perspectives and positions (Summerton 1998). Every viewpoint is part of a broader picture and not the whole picture. Clothed in network terms, multiple viewpoints arise throughout networks and need to be mapped to create a better rendition of the structure and its interactions (Asdal et al. 2001: 40; Star 1991: 44).

The feminist critique of ANT is by now well rehearsed, but the theoretical notions elaborated in it still need to be transported into the history of women as marginal actors in science. Women

have oscillated between presence and absence; they have seldom fulfilled established norms and through not fitting into scientific communities, adding to their complexity. The more multifaceted view of scientific networks growing out of feminist science studies does not take away from the understanding of gender, power and women's marginality. Rather it fuels a more multifaceted understanding of marginality in science. Drawing on her own experience as a woman scientist, American biologist Ruth Hubbard has pinpointed one aspect of this density, namely the porous boundaries in scientific communities and the multifaceted status of the outsider:

> in science the boundary between insider and outsider is permeable. In most respects, I am not one or the other. Almost always I am both [...] So, once more I am back to the dynamic between insider and outsider and the strengths we can gain from their simultaneous coexistence and that surprises and interests me a lot (Hubbard and Randall 1988: 127).

Fractured identities

Historical research has a long-standing interest in the biographies of women in science. This research has displayed how the gendered status of women has had implications for their identity formation (Markusson Winkvist 2003). However, this biographical interest could be deepened by a closer connection to the tools for understanding complex identities elaborated in feminist science studies. Issues of marginality and the permeable boundaries between insider and outsider open up questions about contested and non-coherent identities of (scientific) actors.

Currently, there is a vivid discussion about the "nature, the

power and the intentions of the actor" in STS as well as in feminist science studies (de Laet and Mol 2000: 227). This discussion has been furthered by arguments in feminist science studies about the "situatedness" of knowledge production. Ideas about the neutral and objective position of the scientist have been critiqued at length, and feminists have argued for the importance of thinking about science through the position of the actors producing science. Knowledge is situated in specific contexts, discourses, class relations, times and places.[17] This argument coincides with broader feminist theorizing about the lack of coherent identities, much repeated in the prolific discussion about "cyborgs", drawing on the works of Donna Haraway. She argues that in contemporary society the idea of a coherent identity has become meaningless; cyborg feminism criticizes the idea that lack of a clear identity and a robust self means not having agency. These arguments take seriously, and give meaning to, the ongoing proliferation of "hyphenated" identities (Haraway 1991: ch. 8; Prins 1995: 357–360).

Overall, the inherited philosophical image of the actor as a well bounded, human, and rational man has been radically redefined. ANT has fuelled this discussion by taking "actants" – non-human entities – into account. Thermometers, microscopes, electric cars and even clams act and effect networks and knowledge production (Callon 1986; de Laet and Mol 2000: 226–227; Latour 1987; Law 1986: 16–18). Opening up the category of the actor for reformulation has generated an interest in multifaceted and "split" actors. Anthropologists of science Marianne de Laet and Annemarie Mol have argued that an actor can be "fluid" in the sense that it doesn't need "clear-cut boundaries that come with a stable

17 Asdal et al. 2001: 47, Berg and Lie 1995: 343, Haraway 1996, Keller 1995: 86, Kohlstedt 1999, Kohlstedt and Longino 1997: 3–6, Mayberry et al. 2001, Maynard 1997, Prins 1995: 354–357, Schiebinger 1999.

identity". The actor that they are studying – the Zimbabwe bush pump – does not have a solid character. It is fluid, changing and possible to apply in a range of contexts, but it still has agency (de Laet and Mol 2000: 227).

The history of women scientists has displayed a number of instances where women's gendered scientific identities have produced difficulties in the face of male hegemony. In my own work, I have drawn on the discussions about fractured identities in showing the oscillating status and identity that Eva von Bahr created as an assistant professor in experimental physics. I argued that the 'high tension zone' in which her identity was moulded eventually led to her quitting science in the face of many institutional difficulties (Wennerholm 2009).

Indeed, split identities are potentially an experience laden with suffering. However – repeating de Laet's and Mol's argument that non-stable identities do not mean lack of agency – fractured identities might also be viewed as a way to empowerment (Star 1991). The lived experience of inhabiting a borderland (in the sense of encapsulating different communities and not really fitting in any) might generate a productive rejection of purity and established categories (Bowker and Star 1999: 304–305). Here, the history of women in science is confronted with a large body of theoretical work, not just on "cyborg" feminism but also on post-colonial feminism, e.g. "latina" feminists discussing "border studies" (Anzaldúa 1999: 12). Outsiders, in this line of theorizing, develop flexibility in shifting from "the mainstream" to other "worlds". They have the possibility of breaching and abandoning dichotomies (Anzaldúa 1999; Lugones 1994). Importantly in this discussion, such shifting is "skilful, creative" and "enriching" (Lugones 1987: 3). Even though research on the history of women in science typically highlights

white middle-class women in a way that post-colonial feminism criticizes, the analytical gaze can be transported into the investigations of women in science (Berner 2004: 15).

The breaching of gendered norms is a recurring theme in the history of women in science. Feminist discussions on agency and empowerment in split identities have important theoretical approaches to offer analyses of women who empower themselves and act through an inability to fulfil male norms in science. Breaching norms meant founding women's colleges, building networks among them (and including liberal male collaborators) or moving into new scientific fields not yet laden with gendered ideals. Conversely, however, the history of women in science could deepen our understanding of norm-breaking – and the suffering involved – discussed in other branches of feminist discourse. The natural sciences are pertinent places for such discussions, as historically they have upheld male hegemonies of a uniquely strong character. Consequently, the empirically detailed, local histories of women in science have great potential to add to general issues in the theoretically elaborate discussions in feminist science studies. I will return to this two-way traffic next, in the closing section of this article.

History and feminist science studies: A two-way traffic?

In the present article, I have outlined ways towards what I feel would be a more powerful history of women in science. This research has had a limited impact on feminist science studies with its ambitions to produce theoretical and generalized accounts of gender, science, technology and society. This lack of influence is regrettable. More ambitious engagements in theoretical discus-

sions in STS would give the history of women in science more "epistemic bite" in our endeavours to understand science as a social, historical and cultural practice. A fruitful way of doing this is to more clearly allow theoretical concepts to structure the investigations. There is a persistent idea in the bulk of history of science as well as STS that research on "women's topics" is not informative for more general questions about the structures and practices of science (Berg and Lie 1995: 333, 342–344; Loughlin 1993: 4; Woolgar 1995: 283). But in topics such as the durability of power structures in the sciences, marginality and identity, the history of women in science can augment a deeper and more wide-ranging exploration of science.

This requires a more elaborate discussion among historians about the relation between micro and macro, between small things and large processes. In the words of science historian Steven Shapin: "Whatever can be learned from the detailed, naturalistic study of a particular scientific practice may be applied to our overall understandings of knowledge" (Shapin 2005: 242). I firmly believe that a reconnection of the history of women in science with cutting edge research in feminist science studies can provide ways towards this goal.

Naturally, I am not suggesting that the history of women in science should give up the ambition of performing empirically rich and context sensitive history writing. Rather, I wish for more two-way traffic between the history of women in science and feminist science studies. The former offers historically thick examples, often paradoxical and challenging theoretical models. For example, several STS scholars have criticized ANT for overemphasizing strategies among actors and disregarding enduring hierarchies, traditions and norms. According to the critics, durable practices and

beliefs are the result of historically deep "politics of exclusion" (Hess 1997a: 161; Jasanoff 2004: 23). Different historical circumstances offer restrictions as well as openings; historical actors have diverse resources, openings and limitations depending on the context. Issues of framework are vital: scientists and engineers work in culturally and socially complex contexts where issues of styles, ideals and practices are crucial. Critics argue that ANT portrays actors devoid of historical contexts, starting from a "universal" and non-historical position.[18] Furthermore, the actors are only analysed in their acting, in relation to what they succeed in doing and not doing. Hence, ANT is not suitable for understanding multifaceted, interwoven processes developing slowly over time with a plethora of actors involved (Berner 1999: ch. 6). This critique offers a point of entry for historical research about women in science. The critique fits well with historical sensibilities and could be elaborated by linking it more thoroughly with empirical case studies.

I started out with my personal unease about working as an interdisciplinary scholar, and indeed there are tensions in integrative intellectual discussions. Certainly, to some extent there are assumptions and viewpoints that are virtually impossible to bring together. Historical explorations display continuities and discontinuities over time, while sociological studies address question about how structures, actions and beliefs can be explained using generalized concepts. Historians typically regard theoretical concepts as something that grows from the empirical studies, and something that is produced in close dialogue with the actors under

18 Golinski 1990: 500, Hess 1995: ch. 1, Hess 1997b: 83 and 92–93, Jasanoff 2004: 23, Martin 1998: 27–28.

scrutiny. Accordingly, historians have an unwillingness to draw general conclusions beyond their particular historical case (Berner 1999: ch. 6).

Nonetheless, I wish to advocate an increased dialogue simply because the potential gains should be explored. Historical studies have a great deal to offer in the continuing work of elaborating theoretical concepts and generalist visions of gender and science. The historical research is constantly coming up with challenges to theoretical discussions. Through its ability to display empirical complexities over time and place, this research challenges, for good reasons, the possibilities of generalizations. As sociologist of science Robert Merton has noted, the "theorist who is exclusively committed to the exploration of a total system with its utmost abstractions runs the risk that, as with modern decor, the furniture of his mind will be bare and uncomfortable" (Merton 1996: 49). Thirteen years ago, Evelyn Fox Keller suggested that there "needs to be a lot more two-way traffic in this trading zone if it is to do the work it is capable of doing" (Keller 1995:92). The history of women in science should engage in the trading zone of feminist discourse with confidence in the value of studying the local with empirical rigor and historical perspectives. But it should also more ambitiously open its explorations to other, and different, branches of feminist discourse. It should more consequently contemplate how the local transcends places, contexts and disciplines and if and how this can add to a more general understanding of science.

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MALIN AH-KING | Gender and queer perspectives on Evolutionary Biology

Introduction

Biology has long been of interest to feminist critics, as this is the science that has naturalized sex differences and social injustice (Bleier 1984; Fausto-Sterling 1992; Hubbard 1990). Several different directions in biological research from a gender perspective can be distinguished – science critique, theory development, testing alternative hypotheses and empirical studies. Connected areas, which I will not go further into here, are also history of science and sociological studies of science dealing with women in science, hiring policies and citation frequencies.

Although many areas in biology have been criticized from feminist perspectives – molecular biology (Keller 1983), the related field of paleoanthropology (see Bleier 1984), biological theories about women and men (Fausto-Sterling 1992) – here I will focus on my own area of research, namely evolutionary biology. My aim in this chapter is to give an overview of the recent development within gender perspectives on evolutionary biology, to give a framework that can help the reader recognize different forms of gender bias in biology and to encourage further research. Even within evolutionary biology, there is a special focus on the theory of sexual selection and research in this area. The reason for this focus is that reproduction and sex differences are central to

sexual selection, and therefore gender issues have been most pronounced there. I will first give examples of patterns of andro- and heterocentric bias, which have been and still are in focus for feminist critique: that females have been overlooked or only studied as vehicles for reproduction, that males have been used as a norm, that male dominance has been naturalized and how heterosexuality has been taken as a given. Second, I will present examples of gender bias at different levels in the research process and a short historical survey of the development of sexual selection theory, with a special focus on critiques from a gender perspective. In hindsight, many of these examples of gender bias may seem obvious, but I want to stress that scientific endeavours are dependent on the ideology prevailing in society. Scientific progress cannot be separated from the society in which it is produced, and scientists can never free themselves entirely from political and cultural influences (Rose et al. 1984; Fausto-Sterling 2002).

Unseen females

Three-spined stickleback, *Gasterosteus aculeatus*, is one of the most well studied fishes in the world. Deborah McLennan did her dissertation work on the evolution of nuptial colouration (used in display) in male three-spined sticklebacks and their relatives. After that, she discovered that females also have signalling colours. Despite the intense interest in male colouration in this species, she could find no reference about the female equivalent. Subsequently, she studied the signalling colours of females in several stickleback species and found that female colouration has evolved under different selection pressures from male colouration (McLennan 2000). The lack of work on female colouration is one example of the male-centred bias and of how females have been overlooked.

For a long time, evolutionary theory assumed females to be passive, and in a chapter in *Feminist Approaches to Science*, Hrdy (1986) provided evidence against the myth of the coy female. She points out that notions from Victorian society have coloured Darwin's theory of sexual selection. When females have been studied, it has often been in the reproductive role as a mother (Hrdy 1986). In *Mother Nature*, Sarah Blaffer Hrdy investigates the myth of the ever-good self-denying mother instinct (Hrdy 2000). She presents data on both animals and humans that show how females make reproductive trade-offs, weighing costs and benefits both for themselves and for their infants.

In a chapter about parental care in birds and mammals, despite the widespread distribution of maternal care in these groups, five out of eight subheadings concern male behaviour, such as "Why do males help in parental care?" and "Why do males agree to polyandry?"[1]. Implicitly, females are assumed to be responsible for caring and the notion of females as caring mothers is so omnipresent that it need not be questioned; only the "exceptions" are interesting (Zuk 1993).

Definitions of mating systems

How we define mating systems still relies on the assumption that females are limited by environmental resources, while males compete among each other to monopolize females according to Emlen and Oring's (1977) model. This model presents females as passive resources for males, building the theory of the environmental potential for polygyny[2] - while in reality mating systems are the outcome of the interaction between females and males (Gowaty

1 Polyandry is when a female mates with several males.
2 Polygyny is when a male mates with several females.

Figure 1. Golden female of tree-spined stickleback. Male display colouration has received a great deal of research attention, while female colouration has been over-looked. The Faroe stamp is drawn by Astrid Andreasen, printed with permission from the Postverk Føroya - Philatelic Office, available at Wikimedia Commons under a public domain licence athttp://commons.wikimedia.org/wiki/File:Faroe_stamp_248_stickleback_(gasterosteus_aculeatus).gif

1997). Still, mating systems are often defined in terms based on male monopolization of females (e.g. one-male groups, multiple male groups). However, there are alternative models, for example, Wrangham's model (1979, 1980) of primate social systems, which emphasizes female strategies in relation to ecological resources and social relationships.

Female birds have often been assumed to be monogamous. However, an important experiment started the process of redefin-

ing female roles in mating systems. In the 1970s, red-winged blackbirds had become a pest in some parts of the US. In accordance with current sexual selection theory, Bray et al. (1975) tried to hinder their reproduction by sterilizing territorial males, as males were known to have pair bonds with several females. Females living in the sterilized males' territories produced fertile eggs as usual, which was very surprising to the researchers. It turned out that the presumably monogamous females had mated also with other males (Zuk 2002). Since then, female mating with multiple males has been found to be more a rule than an exception.

The male as a norm

Viewing males as the norm for how a species look, behave or function is most obvious in laboratory experiments, where only males have been used as objects for the study of any kind of physiological phenomena, such as kidney function (Zuk 2002). The cyclic hormonal changes in female bodies have been seen as 'noise', leading to a disturbing lack of information on the normal physiology and medicine of female and women (Zuk 1993).

Language also reveals our androcentric framework, of which the words "man" and "mankind" are striking examples (Zuk 1993). The use of anthropomorphic language has been criticized (e.g., Gowaty 1982), and the critique actually led to a lessening of terms such as "adultery" in animal behaviour in favour of more operational definitions.

Naturalization of male dominance

The first study to develop a theory about dominance hierarchies was made on hens, but why do we always hear about alpha-males and not alpha-hens (Zuk 2002)?

Male dominance hierarchies have gained much attention in the research, to the extent that females showing aggression and fighting for dominance were overlooked. For several years, researchers John Marzluff and Russel Balda put considerable effort into studying the dominance hierarchy among males in a bird species, Pinyon jay (Marzluff and Balda 1992). Because males were very peaceful, they performed experiments and interpreted very subtle signals as dominant and subdominant. The outcome of these experiments was then modelled to produce a scheme over the dominance hierarchy in the group. At the same time, females were found to be immensely aggressive, but the researchers did not take this into account in their search for a male dominance hierarchy.

> "Mated females seem especially testy. Their hormones surge as the breeding season approaches giving them the avian equivalent of PMS which we call PBS (pre-breeding syndrome)!" Marzluff and Balda, 1992. In light of another biologist's, Marcy Lawton and her colleagues', gender analysis of Marzluff and Balda's book, however, females were simply contesting for breeding territories, and the male dominance hierarchy was a result of female dominance relationships (Lawton et al.1997).

Heteronormative biology[3]

Heterosexuality in evolutionary biology is taken as a given, because reproduction is crucial to organisms' existence; unless organisms reproduce, their genes are not transferred to the next generation. Animals try to survive and pass their genes on to the next generation. Heterosexuality is assumed to be the only natural sexuality,

3 Heteronormativity is the ways in which heterosexuality, through everyday speech and acts, is made the only natural and normal way of living, while simultaneously defining other sexualities as abnormal (Kulick 2004).

Figure 2. Pinyon jays. The researchers looked for a male dominance hierarchy and dismissed female aggression as a bird version of PMS, Pre-Breeding Syndrome. In this species, females and not males fight for breeding territories. A photo by Tim Lenz, available at Wikimedia Commons at http://commons.wikimedia.org/wiki/File:Gymnorhinus_cyanocephalus.jpg

and other sexualities are thereby defined as abnormal and in need of scientific explanation (Bagemihl 1999; Roughgarden 2004). In a book published in 1999, Bruce Bagemihl presents an overview of these various sexual behaviours. He found that even when biolo-

gists have discovered same-sex practices or other variation, it has not been reported to the same extent as heterosexual practices. Homosexual behaviours have been made invisible by researchers through desexualizing homosexual behaviours and calling them something else, inadequate recording, and explaining it as a mistake. Homosexual behaviours have been found in more than 1500 species and range between life-long bonds and short encounters. In a few species, for example Greylag geese, some individuals pair-bond only with same-sexed individuals throughout their lives. In most species where homosexuality has been found, animals move freely between homo- and heterosexual activities, and in some species, such as bonobos, all individuals show both homo- and heterosexual behaviours. The reason why we have not known about this earlier is that biologists have not reported their findings, partly because evolutionary theory has not been able to explain these findings and partly because heterosexuality has been assumed. In many species of gulls, females and males are not visibly different. When two gulls are seen together they are often assumed to be a heterosexual couple. Researchers working with gulls have even used mounting behaviour to define which sex an individual has – males are the mounters and females the mounted. However, sexing gulls with DNA technology has revealed that homosexual couples are very common, for example 16% in Black-headed gulls. In the past, many researchers have avoided publishing their findings in fear of losing their grants, reputation or being pointed out as homosexuals themselves. Nowadays, variation in sexual behaviours is published, but still often in the light of human morals. For example, an article about same-sex pairing in butterflies from 1987 is entitled "A note on the apparent lowering of moral standards in the Lepidoptera".

Species and life forms that do not follow the two-sexed heterosexual norm are called alternative. Parthenogenetic species (consisting of only females) are described as evolutionary dead ends; those animal variants that do not conform to the choosing-female-and-competitive-male pattern are labelled as using "alternative reproductive tactics", and species that do not follow the perceived usual pattern are defined as "sex-role reversed" (Ah-King 2009). Thus the norm is upheld by referring to exceptions, but in both the case of sex and sexuality, there is a large range of variation that is not easily dichotomized into "normal" and "alternative".

Stereotypic notions at different levels

Stereotypic preconceptions of femaleness and maleness affect the research process at different levels, from theory, predictions and data collection to the interpretation of data. Here are some examples.

Theory

In an analysis of ornithological natural history narratives, Lawton et al. (1997) reveal gender bias in descriptions of behaviour at the level of molecular analysis as well as the individual and population level. They show that the theory, the preconceived frames of knowledge, affects which questions are possible to ask and therefore which answers we can obtain. One striking example is when Pinyon Jay researchers ignored the importance of female aggression, because male dominance hierarchies was the focus of their research (see above).

That the diversity in homosexual behaviours has been ignored for so long is also an effect of how theory has restricted our view of biological diversity.

Choice of model organism

Despite the large variation in primate social organization and mating systems, baboon societies have been the most used model for human evolution (Tang-Martinez 1997). This choice of model organism is probably due to the parallel researchers perceived between male dominance and aggression against females in human and baboon societies. Comparing human and chimpanzee behaviour has also been common, but bonobos are just as closely related to us as chimpanzees and comparison to their behaviours yields very different perspectives (de Waal 1997).

Data collection

In early primatology, the most used research method was to make observations *ad libitum* (spontaneous noting of events), which resulted in an over-focus on male aggression (Haraway 1989). Primatologist Jeanne Altmann criticized earlier observational methods, as they could not be used to answer questions about rates or durations of events, nor to compare, for example, the difference in time that females and males spent eating or grooming. Altmann introduced a new method, focal animal sampling: to focus on one individual for a certain amount of time, note what this animal does and then focus on another individual (Altmann 1974). This method is now widely used in animal behaviour studies and provides a more complete picture of what all animals in a social group are doing. This method has also made explicit the sometimes subtle behaviours and strategies that females use.

Perception

Giant waterbugs are insects, and the males carry eggs on their backs. For a long time, the males were assumed to be females.

Researchers at the time speculated about the non-existing egg laying tube that ought to be as long as the bug itself in order for it to be able to lay eggs on its back. At the end of the 19th century, a female researcher realized that it was the male that carries the eggs. However, as she too was influenced by cultural conceptions of maleness and femaleness, she described the male waterbugs as utterly unwilling to care for the eggs and as preferring death to having eggs glued onto their backs (Fausto-Sterling 2002). Her interpretation is still another example of how preconceptions obscure researchers' perception.

Interpretation of data

Spotted sandpipers are birds with a mating system in which females breed sequentially with several males and each male broods and takes care of one clutch of eggs. In a molecular analysis of paternity, the researchers discovered that males are not always the biological father to the young they care for and they described the phenomenon as male cuckoldry by their female's previous mates. It was also surprising that sperm could be stored for a long time and that females could produce several clutches before using the stored sperm. The report was called "Cuckoldry Through Stored Sperm in the Sequentially Polyandrous Spotted Sandpiper". In a gender analysis of this study, Lawton et al. (1997) point out that females are presented as mere passive vehicles for sperm storage, while males are seen as active, which makes the pattern of paternity incoherent. However, when viewing females as actively pursuing reproductive strategies, the pattern becomes comprehensible. When females use stored sperm, they use that from their first mating, which might be their preferred mate. Furthermore, many broods were of mixed paternity and females may also lay eggs

Figure 3. Giant waterbugs. For a long time the egg-carriers were assumed to be females. However, in Giant water bugs, males carry and care for the eggs. Photo by Matthew Robinson, available at Wikimedia Commons at http://commons.wikimedia.org/wiki/File:Toe-Biter.jpg

in other females' nests. Evidently, females are making complex reproductive decisions resulting in a complex pattern of mixed-parent broods that might be adaptive in the uncertain environment these birds inhabit (Lawton et al. 1997).

Sexual selection theory and its critics

Darwin's theory of natural selection is well supported by data and can largely explain the diversity of extant and extinct biological life (Futuyma 2005). Natural selection explains adaptive evolution as a result of enhanced survival of individuals possessing heritable traits in a certain environment, leading to a higher frequency of

those traits in subsequent generations. In contrast, Darwin's theory of sexual selection has been widely debated. Sexual selection was aimed at explaining the occurrence of elaborate male traits that were obviously costly in terms of survival and therefore impossible to explain by natural selection. Sexual selection is a subset of natural selection, and the process of sexual selection concerns differential reproduction. Darwin proposed two mechanisms by which sexual selection could occur: intersexual selection (between-sex interactions), mainly via female mate choice, and intrasexual selection (within-sex interactions), largely through contests between males. As pointed out by many researchers, Darwin was influenced by the Victorian worldview of his time (e.g., Russett 1991), and when describing sexual selection he wrote:

> "...the male is the more active member in the courtship of the sexes. The female, on the other hand, with the rarest exceptions, is less eager than the male... she is coy, and may often be seen endeavouring for a long time to escape from the male…"
> (Darwin 1871)

The first feminist critique of sexual selection theory came already in 1875 by Antoinette Brown Blackwell. She criticized Darwin for having put too much focus on males and suggested that for every special character males have evolved, females have evolved complementary ones (Brown Blackwell 1875).

It is important to note that both male-male competition and female choice are examples of how variance in male reproductive success (number of mates) is generated, which is one of the reasons why sexual selection in females has been considered less important (Gowaty 1997).

Even though Darwin clearly thought that female choice was important, contemporary scientists did not recognize its significance, partly because in Victorian society females were assumed to be passive in the mating process and partly because, for example, insects were not thought to have the intellectual abilities to distinguish small aesthetic differences that were needed to perform a choice. For a long time, the importance of sexual selection was de-emphasized in relation to natural selection, but once research started in this area in the 1960s, the misapprehension of female choice resulted in a skewed focus on males in sexual selection research. In behavioural ecology, e.g., the study of the ecological and evolutionary basis for animal behaviour, the vast majority of both theoretical and empirical research has focused on male behaviour, leaving females mostly unstudied (Fausto-Sterling et al. 1997). In the 1960s, concurrent with the feminist movement, there was an increase in the number of women in science, especially in primatology – and these scientists questioned that females were portrayed as passive in theory. In their empirical data, females were active and had strategies that counter-acted those of males. Concurrently with the feminist movement, Robert Trivers developed parental investment theory, which predicts that the sex that invests most in offspring (e.g. care, lactation, gametes) will be more discriminating in mating and the sex that invests less will be competitive for access to the high investing sex. These ideas generated numerous empirical tests and put the study of female choice onto the research agenda. In light of these changes, females began to be perceived as active subjects that influence evolutionary processes (Gowaty 2003).

One example is Sarah Blaffer Hrdy's studies of male infanticide in Hanuman langurs (primates). She found that females tried to

prevent their infants from being killed by new male group leaders, by obscuring paternity and actively seeking to mate with several males, including those outside their current group (Hrdy 1986).

However, what Darwin did not explain with his theory was why choosy females and competing males seemed more common than choosy males and competing females. Later researchers have tried to explain this phenomenon based on Bateman's classical experiment on fruit flies (Bateman 1948). After allowing a small number of fruit flies, *Drosophila melanogaster*, with visible genetic markers to mate and reproduce for a couple of days, Bateman was able to count the offspring sired by different males and females. He thus showed that the difference in reproductive success was greater among males than among females, and this result was taken as evidence of male-male competition and female choice, thus sexual selection in action. Later theoretical work has revealed that Bateman's result could be explained by both sexes mating randomly (e.g., individuals take partners at random, they do not perform mate choice or compete for mates) (Sutherland 1985). Thus, differential variance in reproductive success between the sexes cannot alone be inferred as evidence for sexual selection in process.

Furthermore, there is evidence of strong sexual selection in females, for example, dominant female marmosets (primates) inhibit subordinate females' reproduction through behaviour and hormones; dominant females prevent subdominants from mating and hormones suppress ovulation in subdominants (Abbot 1984). In addition, female strategies are often not as obvious as male strategies, but sexual selection is not less important for them, as exemplified by how the Hanuman langur females obscure paternity.

Building on Bateman's principle, the anisogamy argument was

developed, which argues that because males produce many and small gametes (sperm) and females produce few and large gametes (eggs), male gametes will compete for access to female gametes. Furthermore, as the argument goes, this fundamental difference in gametes predetermines males for competition and females for mate choice. Building on this reasoning, Trivers (1972) proposed that the common pattern of male competition and female choice was due to parental investment, that females usually invest more in offspring. Also, females are assumed to invest more in parental care owing to their initial large investment in each egg.

Studying sex-role reversed species as a way of testing parental investment theory has given mixed results. In pipefish and seahorses, the male broods the eggs in a pouch or attached to the stomach and females are therefore predicted to compete among each other for access to males. In straight-nosed pipefish, *Nerophis ophidion*, females do indeed compete among each other for males and males are choosy (Rosenqvist 1990). In contrast, seahorse males compete for females despite their large investment in parental care, and both males and females perform mate choice (Vincent 1994). Thus, seahorse males do not limit female reproductive success. Hence, for many sex-role reversed species, it is still unclear how ecological conditions favour asymmetries in the behaviours of the sexes (Vincent et al. 1992; Okuda 1999).

The anisogamy argument and parental investment theory imply the evolution of *genes for* innate choosiness in females and competitiveness in males (Gowaty and Hubbell 2005). However, empirical evidence is accumulating that males may manipulate females into becoming choosy. For example, male fruit flies have been shown to transfer chemicals during mating that make females less willing to re-mate (Chapman et al. 2000). Thus females

are not innately coy, but can be influenced to prolong their time before remating.

In contrast to the above models of genes for innate choosiness in females and indiscriminate mating in males, Patricia Gowaty has suggested that selection favours individuals that are flexible and dynamic in their mating behaviour. This hypothesis has generated a model of gender-neutral flexible sex roles (see below).

After Bateman's study, the dominant view has been that sexual selection is always stronger in males. Hence, within-sex reproductive competition among females has been considered less important than sexual selection in males, and sexual selection in females has received less attention. However, the definition of sexual selection is variation in reproductive success within a sex, which was emphasized by Darwin in 1871. Too much confidence in Bateman's principle has hindered the study of many important phenomena in sexual selection, such as the role of females seeking extra-pair copulations, the role of females in leks[4] where polyandry has been found to be common, the importance of variation in female reproductive success, male choice and the cost of sperm production (Hrdy 1986; Gowaty 2003). Critique of the anisogamy argument has been manifold (Hrdy 1986; Gowaty 1997; Tang-Martinez 1997). However, within mainstream biology this argument is still cited (e.g. Barlow 2005). Recently, Bateman's experiment on fruit flies has been scrutinized by Snyder and Gowaty (2007). They found a number of errors in Bateman's study, such as sampling biases, miscalculations and statistical pseudo-replication. Furthermore, already in Bateman's study there was evidence of *a positive correlation* between multiple mating in females and repro-

4 Lek is a mating arena where males gather and perform mating displays in order to compete for and attract partners.

ductive success, which is exactly the opposite of what Bateman's experiment has always been cited for.

Another way in which female behaviours have been neglected in sexual selection theory is the failure to appreciate that differential reproduction can actually result from other behavioural interactions besides mate choice (Gowaty 1997). For example, males may coerce female mate choice (Smuts and Smuts 1993; Gowaty and Buschhaus 1998).

Repeatedly, the development of sexual selection theory has abandoned stereotypic notions and replaced them with more variable views. Coy, passive and monogamous females were replaced by females with active mating strategies. The discovery of multiple mating by females led to a new field of research, namely sperm competition[5], which describes male-male competition after mating. This male-focused view of sexual selection after mating dominated the research for many years, and the proposal of the reciprocal idea of female choice after mating, cryptic female choice[6], initially met great resistance (Ben-Ari 2000). Nevertheless, the idea has stimulated research, and the discussion about the relative importance of cryptic female choice versus sperm competition in sexual selection after mating continues.

The theory of sexual selection has also been criticized for its focus on a two-sex system and heterosexuality – males and females as a general model does not apply to the diversity of sexes

5 Sperm competition is defined as the competition between different males' ejaculates for fertilization of a given set of eggs.

6 See William Eberhard's book "Female Control: sexual selection through cryptic female choice."

and genders[7] in nature (Roughgarden 2004). Due to Darwinian theory's focus on heterosexuality as the means to reproduce, evolutionary biologists have largely overlooked the variation in sexual practices found in animals (Bagemihl 1999, see section on heteronormative biology above).

In conclusion, sexual selection theory has a long history of andro- and heterocentric bias in both theory and practise, but as we have seen, this field of study is changing.

Sexual selection theory today

Currently, as results from, for example, paternity analyses are accumulating evidence for almost ubiquitous female multiple mating, sexual selection theory is transforming. Today, the normal science of sexual selection has partly incorporated the role of females in evolution (Arnqvist and Rowe 2005). There are more sexual selection mechanisms than the traditionally acknowledged male-male competition and female choice (males may aggressively condition female behaviour).

Feminist theory generating testable hypotheses in evolutionary biology has lead to exploration of hypotheses of male coercion of female mate choice (e.g., Gowaty and Buschhaus 1998). Large male body size is traditionally explained by male-male competition, but an alternative suggestion is that males by force coerce female mate choice, as exemplified by Coho salmon. According to the traditional view, large males are perceived as preferred by females and small males are usually termed 'sneakers', which are thought to

7 Biological sex is defined by the production of eggs and sperm. Gender is not commonly used in evolutionary biology except as a synonym for sex, but could be seen as sex differences in behaviour, or as suggested by Roughgarden (2004), "the appearance, behaviour and life history of a sexed body". There is no dichotomy between sex and gender (appearance and behaviour) in evolutionary biology; both are viewed as functions of how ecological variables influence organisms.

interfere in the females' choice of males. However, surprisingly, it is the males with the highest viability and fastest growth rates in the juvenile stage that become sneakers. A recent study shows that female Coho salmon prefer mating with small males, as this leaves them more time to mend their nests and they also lay eggs for a longer time when small males are present (Watters 2005). Larger males act more aggressively towards females. These findings suggest that large males can instead be labelled 'coercers' and small males 'co-operators' (Watters 2005). However, it is important to note that a large proportion of contemporary evolutionary biology could very well be labelled gender research, such as studies of species with "reversed sex roles", cryptic female choice and studies of variation in sex and gender.

Lately, traditional sexual selection theory has been challenged by alternative models. Joan Roughgarden (2004) points out that evolutionary theory is based on individual competition and that cooperation between animals is neglected. She argues for a rejection of the theory of sexual selection and presents an alternative theory based on cooperation (Roughgarden 2004). Roughgarden et al. proposed a game theory model (2006) to replace sexual selection theory. I do agree that male bias has and probably still influences theory and research in sexual selection, however calling sexual selection refuted is clearly a case of throwing out the baby with the bathwater. Roughgarden has misrepresented sexual selection theory and research, (see responses to Roughgarden 2006 in Science). Furthermore there is now an interesting alternative model to traditional sexual selection, namely Patricia Gowaty and Steve Hubbell (2005, 2009) models for flexible sex roles. This models are gender-neutral – no attributes are predetermined to either sex, instead each individual is predicted to act in a choosy, indiscrimi-

nate or competitive manner depending on a few life history variables that we know influence mate choice and competitiveness. Assumptions about behaviour are based on availability of mates, survival probabilities, life history variables, time constraints due to handling mates (mating, mate guarding) and those between matings due to parental care. Future testing of the model will prove whether it is better at predicting mate discrimination and competitive behaviours than traditional sexual selection theory is.

In order to fully understand the variation and diversity found in nature, it is not enough to add studies on females or reverse theory on sex roles (Jackson 2001), as this does not account for those individuals that fall outside our predefined categories, such as female and male. Or as Donna Haraway puts it (1986), male-centred accounts cannot be replaced by female-centred ones; substitutes do not destabilize, they replicate. We need to break up our cultural notion of sex, the imagined dichotomy between female and male (Jackson 2001), and our notion that, using Myra Hird's words, 'femininity and masculinity are categorically different and complementary' (Hird 2006). Myra Hird shows that bacteria, with their diversity of sexes and exchange of genes between species, destabilize our notions of female and male. This is also what my and Sören Nylin's model of variation in sex and sexuality aims at. We propose that interactions between genes and environment produce the variation in sexes and gender attributes that nature entails. In this sense, sex is merely one among other traits that can be modified by selection, leading to evolutionary diversity (Ah-King 2009; Ah-King and Nylin, forthcoming).

The sociobiology controversy

Biological determinism, the hypothesis that biological factors determine an organism's behaviour, is frequent in biology (Rose et al. 1984). According to the biological determinist argument, human gender differences in behaviour are accounted for by biological differences in genes, hormones or brain structure and conventional sex roles have evolved adaptively. Strict biological determinism receives little support among biologists, as they are aware of the influence of environmental and social factors, though there are great differences among biologists regarding how much emphasis they put on the role of biological factors as opposed to social factors. However, biological determinist arguments are still prevalent in biology and even more common in popular presentations of biological research (Bagemihl 1999).

Sociobiology, the study of social behaviour in an evolutionary perspective, is uncontroversial when it comes to animals. But when evolutionary approaches are applied to human behaviour, it has been and still is a controversial issue, and not only among feminists (Bleier 1984; Rose et al. 1984; Tang-Martinez 1997; Laland and Brown 2002). The feminist and other scientific critique of sociobiology is largely focused on the lack of possibilities to test the hypotheses rigorously, especially sociobiological research on humans (Rose et al. 1984; Tang-Martinez 1997). Critics (Rose et al. 1984) claim that sociobiological language often slips from what "is" to what "ought" to be, causing sociobiologists to argue that social reforms are against human nature. Scientific critique of sociobiology has emphasized that it 1) rests on anthropomorphism (ascribing human motivation to animal behaviours), 2) is dogmatically adaptionist (one-sided focus on adaptionism as an explanation of behaviour, though there may be many non-adaptionist explana-

tions), 3) produces just-so stories (builds on adaptive explanations that lack evidence) and 4) produces non-falsifiable hypotheses (Rose et al. 1984; Tang-Martinez 1997). The application of evolutionary theory to humans has a history of social Darwinism and eugenics, which led to the sterilization of people (in Sweden until 1975) and the holocaust. At the same time as evolutionary theory and research on animals is becoming less gender biased, a new branch of sociobiology is flourishing, namely Evolutionary Psychology, which provides evolutionary explanations of human behaviour. Evolutionary psychologists build their theory on stereotypic notions of females and males. They argue that because men can produce many sperm they must be selected to seek many matings with multiple partners, and because women produce few eggs and invest in a nine-month-long pregnancy, they should be selected to be choosy (Fausto-Sterling et al. 1997). Thus, changes in the comprehension of sex roles and sex differences in current evolutionary biology have not been incorporated into Evolutionary Psychology, which is also extensively criticized by biologists (e.g., Fausto-Sterling et al. 1997; Gowaty 2003), not to mention by feminists and social scientists. (For an argument in favour of the inclusion of Evolutionary Psychology into feminist theory, see Vandermassen 2004, and response: Ah-King 2007).

However, Laland and Brown (2002) point out that while the sociobiology debate has been characterized by polarization and political accusations, a more balanced position is possible. It is important to acknowledge the historical misdemeanours at the same time as it is possible to evaluate what evolutionary approaches may contribute to our understanding of human behaviour.

Prospects

Feminist critique of biology has not led to a separate field of gender research within biology. Instead, most researchers working in this area have a research position in biology and have gender studies more or less integrated into their biological research. An involvement in gender issues and biology research has often been combined with or originated in an engagement in the women's movement. Through this work, many feminist insights have been incorporated into and reshaped mainstream science.

However, we still need to increase our awareness of how evolutionary biology historically has been and still is biased towards a focus on males and heterosexuality. We need to change both theory and research practice to develop an evolutionary biology that is characterized by a gender-neutral understanding. I agree with Zuk (1993) that an awareness of bias can make us all better scientists, and I hope that this overview will inspire many researchers to contribute to a more gender-neutral evolutionary biology. By gender-neutral I mean that we should not assume in advance that females and males are in any certain way.

Gender bias and heteronormativity constitute two major challenges to evolutionary biology that we need to confront if we are to fully understand the diversity of sex and sexuality found in nature. Engaging in such critical self-reflection can broaden our frames of knowledge by helping us to recognize alternative hypotheses and question underlying assumptions of theories, point out new directions for research and be an active driving force for change in theory and research practices. Ultimately, this is important because evolutionary claims affect interpretations of not only animal behaviour, but also human behaviour, political debates, and in the end policy-making and legislation. Relieving biol-

ogy from biases can therefore liberate people from the oppression caused by biological claims about what is natural.

Suggested readings

Feminism and evolutionary biology, boundaries, intersections and frontiers (Gowaty 1997).
Sexual Natures: How Feminism Changed Evolutionary Biology (Gowaty 2003).
Sexual selections, what we can and can't learn about sex from animals (Zuk 2002).
Biological Exuberance (Bagemihl 1999).

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REBEKAH FOX | Gender and Animals

> Animals are the ultimate Other. Most of us have been afraid (or unwilling) to journey across the species divide to construct a more inclusive social theory (Wolch & Emel 1995: 632).

Traditionally little attention has been paid to non-human animals within the social sciences, which have been seen as guilty of 'studying humans in isolation, as if our species had somehow evolved in the absence of interactions with anyone or anything else' (Podberscek, Paul & Serpell, 2001: 3). Within gender studies animals were seen as 'outside' of mainstream feminist concerns and indeed associations with animals were sometimes even deliberately avoided because of previous essentialist discourses surrounding women and nature. However recent work within feminist environmentalism, science and technology studies, sociology and animal geography (Birke 1994; Arluke and Sanders 1996; Wolch and Emel 1999; Philo and Wilbert 2000; Whatmore 2002; Haraway 2003) has increasingly recognized the importance of non-human actors in the fabric of everyday social life and challenged taken for granted notions of human uniqueness on the grounds of agency and intentionality. This work has challenged traditional Cartesian notions of the binary divisions between nature/culture, humans/animals and wildness/civilization and raised new theoretical and

ethical questions concerning human relationships with the non-human world.

The field of 'animal studies' emerged particularly during the 1990s and 2000s, linked to connecting theories of post-humanism and actor network theory and spanning a wide variety of disciplines from science studies to art criticism. Whilst work on gender and animals is still relatively rare (Birke 2002), if one looks more closely at the fields of gender and animal studies numerous interconnections emerge. My own work on gender and science in the practices of pedigree pet-breeding (Fox 2008) examines these connections through the language and performance of animal breeding and showing. Pedigree breeding is inherently linked to scientific discourses of genetics and lineage, as well as particular human cultures of race, class, inheritance, competition and display. Such practices draw upon essentialist discourses of 'animality', breed, and gendered 'natural' behaviours, as well as human powers to control the 'natural world'. Pedigree ownership is also strongly linked to specific human social, cultural and gender identities, which are negotiated through relationships with individual animals and breed organizations. Thus connections are not straightforward, but interwoven in a variety of everyday practices that operate on different levels through the intersectionalities of gender, race, sexuality, species and class.

In this chapter I examine the existing literature on the subject and consider the interconnections between gender and animal studies on three different levels:

1) A theoretical / political connection through notions of the nature/culture divide, which has been used to justify the multiple oppressions of sexism, racism and speciesism.
2) The use of concepts of animals and gender within scientific practice and language, which lead to both the gendering of animals (for example in evolutionary biology) and the 'animaling' of gender.
3) Other connections between gender and animals, such as the creation of specific gendered identities through animals, for example masculinity and hunting, men and meat-eating, pet-keeping and domesticity, women and the animal rights movement.

Theoretical / Political Connections

Western Enlightenment traditions of reason, rationality and scientific thought have been the focus of much critical engagement within the humanities and social sciences over the second half of the twentieth century. Critics from feminist and anti-racist perspectives have challenged the traditional Cartesian dualisms between culture / nature, mind / body, man / woman and self / other, that have privileged the rational, disembodied 'master subject' (white, male, heterosexual, bourgeoisie) and justified the oppression and domination of those considered 'irrational' and 'natural', such as women, people of colour, animals and nature (Rose 1993).

Feminist science studies have deconstructed the traditional location of animals and humans within scientific schema and explored the ways in which recent developments in science, including biotechnology, are blurring boundaries between the categories of culture and nature, humans and animals, and humans and

machines (Haraway 1991). Evolutionary theory and more recent scientific and genetic discoveries continue to emphasize the similarities rather than differences between human and non-human animals, leading Haraway to argue that 'by the late twentieth century, in United States scientific culture, the boundary between human and animal is thoroughly breached' (Haraway 1991: 152). Animals have also become an important political concern in recent years with issues such as hunting and BSE dominating media headlines and increasing concern for animal welfare and rights (Singer 1975; Reagan 1983). Following popular twentieth century movements against sexism, racism and homophobia, such theorists have coined the term 'speciesism' and view animals as another form of socially oppressed group (Philo 1995).

Such analogies do not wish to denote some kind of simple affinity between women and animals, but recognises the complex ways in which feminist, animal and environmental issues are intertwined. In the past, many feminists have avoided the subject of animals because of a rejection of biological determinism and the disciplinary divides between the social and natural sciences (Birke 2002). However, by applying theories of social constructionism only to other humans, they are actually reinforcing the separation and oppression of non-human animals. 'Animality' is not only deeply intertwined with concepts of gender, race and sexuality, but is itself just as deeply constructed as gender or humanness (Birke, Bryld & Lykke 2004). Thus, the notion of 'intersectionality' is extremely important when studying gender and animal relations (Lykke 2005) if we are to understand the ways in which multiple forms of oppression and social exclusion operate.

Traditional animal rights theory argues for the allocation of 'rights' to animals on the basis of their similarities to humans, such

as their ability to feel pain, express intelligence, emotions or problem solving abilities. However, recent work within the fields of critical and feminist environmentalism (Plumwood 2002; Seager 2003) has criticized animal rights theories, arguing that they go about addressing these problems in the wrong way and allow for erasure of difference and elevation of 'higher' animals to the status of humanity, whilst maintaining unsustainable attitudes towards the environment and 'lower' animals, which are reduced to the category of resources or 'things' for human exploitation.

Feminist environmentalists such as Seager (2003) and Plumwood (2002) argue that many animal rights philosophers are guilty of 'neo-cartesianism' – simply trying to extend the privileged category of humans in the human/nature dualism rather than trying to break the dualism down (Plumwood 2003: 143). By admitting animals perceived to be more similar to humans, such as pets or primates, into the category of sentient beings through recognition of certain human-like characteristics, we are simply re-drawing the boundaries and allowing for other less similar animals or organisms, such as insects or plants, to continue to be treated as resources for human exploitation. They believe that a sharp cut-off point for the boundary of moral consideration is neither necessary nor desirable and that we instead need to recognize the continuity of all life forms and try to come to terms with what kinds of 'care, regard and responsiveness' (Cheney 1994:158) might be possible for us in a relationship with all members of the non-human world. Recognizing this involves an appreciation of difference and respecting animals for their own 'intrinsic worth, integrity and autonomy' (Shiva 2000: 74) rather than on the basis of their similarity to humans.

One way in which feminists have tried to think about the con-

nection between humans and non-humans is by focusing upon the relationship. Ecofeminists have argued for an 'ethics of care' that recognizes the importance of personal emotion in moral decision-making (Donovan 1990, 1994). Traditional animal rights theory has rejected personal emotion as a basis for ethical choice, arguing that this must be based upon 'rational' arguments such as the utilitarian focus of Singer (1975) (which aims to create on balance the least suffering for all) or Regan (1983) (who talks of animals having individual rights on the basis of their similarity to humans). Ecofeminists argue that our decisions cannot be separated from our personal experiences and talk of a 'relational ethics' formed through interactions with both human and non-human others rather than one based upon individual moral rights.

Such ideas recognize the importance of non-humans within the social fabric of everyday life, seeing this as constituted through a series of interacting 'webs' and 'networks' of activity, which challenge not only human notions of 'uniqueness' and 'agency', based upon criteria of language and intentionality, but also the purified spatial divisions of 'nature' and 'society', 'humans' and 'animal' (Instone 1998). They require profound changes in the geographical imagination, recognizing nature not as 'a physical place to which one can go, but an active, changeable presence already always in our midst' (Haraway 1992: 66).

One author who has worked explicitly with notions of relationality is Donna Haraway in her recent works *The Companion Species Manifesto* (2003) and *When Species Meet* (2008). Haraway considers the history and significance of dog training and breeding and the importance of dog-human relationships for understanding specific and individual relationships of love and interaction across the species barrier. She examines what she calls the concept of

'otherness-in relation', looking at the various ways in which people attempt to understand non-human agency and form a 'relational ethics' through their relationships with their companion animals.

Similar ideas are also taken up by Birke, Bryld and Lykke (2004) in their explorations of animal 'performativity'. In a similar vein to the notion of 'queering', the idea of 'animaling' is to shift the perspective from a focus on animal essences and instincts to a study of the material-semiotic performativity of human – animal relationships. This helps to challenge the human / animal dichotomy by recognizing both parties as active agents in the relationship, for example in the case of laboratory rats. The focus upon non-human *doing* or *becoming* recognizes how relationships are co-constructed through multiple actions and shared understandings.

Gender and Animals in Science

Science and particularly biology has often been seen as the appropriate place to study animals and 'nature', whilst the social sciences have tended to concentrate upon humans. Scientific studies of animals have been the focus of a great deal of criticism from feminist scholars, from both within (Gowaty 2007; Ah King 2008) and outside the discipline (Birke 1994; Andersson 2006), particularly ideas of evolutionary psychology, which tend to read animal behaviour in terms of dominant models of 'natural behaviour' or instincts, refusing ideas of individual agency or cultural life. Such approaches can (fairly) be accused of essentializing animal behaviour – reducing it purely to biology and failing to consider the animal as a subjective individual with a specific personality, feelings and emotions.

Evolutionary psychology is seen as highly problematic and controversial when applied to human society (Morris 1967) and

has been widely criticized by feminists and others (Rose & Rose 2000) as reductive and deterministic, often used to justify societal domination and oppression. *The Naked Ape* by Desmond Morris caused an outrage when it was published in 1967, by considering humans as just another animal. Morris argues that humans, in the same way as other animals, are driven by powerful inborn urges and that much of human sexual, feeding, rearing, exploratory and fighting behaviour can be explained through our descent from our primate ancestors and the changes made through natural selection as 'we' moved out of the forests to become hunters. Such animal impulses, he argues, are deeply embedded in our society and explain, for example, the formation of loving pair bonds amongst humans, which arose from the need for faithfulness when males went out to form hunting parties.

In some cases human behaviour is compared directly to that of animals, for example Morris claims that 'When you put a name on the door, or hang a painting on the wall, you are in dog or wolf terms, for example, simply cocking your leg on them and leaving your personal mark there' (Morris 1967: 124). The book received widespread criticism, both from religious parties who claimed that it was attacking the very foundations of human uniqueness and spiritual dominion over the animal kingdom and also from other more radical fronts, particularly feminists who claimed that such arguments are often used to justify continued domination and oppression of women in society. Morris justifies males going out to work as a continuation of male hunting behaviour, while women stayed behind to look after the young. He claims that all-male clubs are a vital part of male psychological bonding, relating back to hunting groups in primitive society and that women should be glad when men go out to the pub without them!

By comparing humans with animals, we extend our own values onto the animal kingdom, while at the same time using our interpretations of animal behaviour to 'naturalize' certain traits in human behaviour, such as mothering and fathering roles, male aggression and female coyness (Crowther 1993: 128). The idea that penetrative sex is an overwhelming, uncontrollable, genetically programmed urge in the animal kingdom is used to 'justify' aggressive sexual behaviour in the human male, and the concentration on reproduction is used to render homosexual sex 'un-natural', thus reinforcing bigotry and prejudice. Rose and Rose (2000: 2) cite the example of two evolutionary psychologists, Randy Thornhill and Craig Palmer, who attempt to use such arguments to justify the 'naturalness' of the male sexual urges involved in rape. They argue that rape is an adaptive strategy by which otherwise sexually unsuccessful men propagate their genes by mating with fertile women, drawing on examples of forced sex in the animal kingdom (for example among mallards), which they insist on classifying as 'rape'.

Such arguments clearly demonstrate the dangers involved in accepting such 'socio-biological' approaches to human behaviour and have been the subject of wide criticism in feminist and academic fields (Rose & Rose 2000; Crowther 1993). The two-way traffic of ideas between human and animal 'socio-biology' means that 'biological' explanations of animal 'instincts' are used to justify and 'explain' certain human behaviours, whilst human social patterns such as heterosexuality, dominance, hierarchy and aggression are 'naturalized' by being 'found' in particular (deliberately selected) communities in the animal world. Gender scholars argue that it is no more justified to essentialize animal behaviour into one dominant model than it is for humans and have produced

numerous examples of alternative behaviours in the animal kingdom, such as homosexuality and nurturing roles amongst fathers (see chapter by Ah-King in this volume). Recent studies with apes have also looked at animal conceptions of human gender (Segerdahl 2008) arguing that cultural understandings of these concepts are possible beyond the human realm and 'culture' cannot be seen as a purely human phenomenon.

One example of where animal behaviour has been used to justify human sexual and gender norms is through the production of wildlife films and natural history television (Crowther 1997; Ganetz 2004). Such films prioritize not only 'wild' nature in its pristine state, but also 'natural behaviours' such male aggression or female 'mothering instincts' and human conceptions of the nuclear family. Meanwhile, supposedly 'unnatural' same-sex sexual practices are played down as 'mistakes' (if they are shown at all) thus reinforcing hetero-normative justifications of both human and animal behaviours (Ganetz 2004). The voice-over in such films is one of detached (usually male) scientific objectivity, and human interactions with animals (including the presence of the film crew) are removed from the scene to avoid disrupting the impression of 'pure' nature.

There has also been feminist work on the use of animals within science. There is a long history of connection between women and the animal rights movement, stemming from the anti-vivisection and welfare movements of the nineteenth century (Lansbury 1985). More recently studies have focused upon the gender relations and human-animal interactions of people working in animal laboratories (Birke 1994; Anderson 2006). These highlight the active role of the animals in laboratories and the various strategies employed by laboratory workers in dealing with ambiguous feel-

ings about the use of animals for scientific purposes (Holmberg 2008). Birke argues that traditional scientific practice demands objectivity and suppression of 'feminine' emotions, thus part of the process of becoming a 'scientist' (for both men and women) is to distance oneself from the animal. This is aided by various rhetorical language devices, such as the metaphors of 'sacrifice' or 'putting away' when discussing the issue of killing animals.

Animals and Human Identity

Attitudes and practices towards animals have been important in the construction of a wide range of gender, class, racial, national and personal identities across various times and places. Such identities can be deliberately constructed by individuals themselves, normalized through particular cultural understandings or practices, or ascribed positively or negatively by others. In my own work (Fox 2005, 2008) I study the ways in which human identities are constructed through ownership of pets, with a particular focus on pedigree animals with their connotations of gender, class, breeding or national identity (e.g. 'British bulldog'). For example particular breeds such as pit bulls are linked to notions of tough white working-class masculinity, whilst breeding of exotic pedigree cats such as Persians or Siamese is associated with upper-class femininity and refinement. Similarly owners of unusual pets such as reptiles use these in the construction of 'alternative' (usually masculine) identities linked to notions of power and danger, and related virtual, musical or gothic sub-cultures (Fox 2006; Beck and Katcher 1996).

The idea of pet-keeping itself has long been associated with domesticity and its feminine and sentimental connotations (Kete 1994) with the 'domination and affection' towards pets linked

with that towards other beings such as 'women, children, plants, dwarves, slaves and fools' (Tuan 1984). In Britain the nineteenth marked 'a fundamental shift in the relationships between humans and their fellow creatures, as a result of which people systematically appropriated power they had previously attributed to animals and animals became significant primarily as objects of human manipulation' (Ritvo 1987: 2). Howell (2000) argues that such 'domestication' was not confined to animals alone, but also to human beings such as women and servants, who were domesticated and confined to the private spaces of the home. In his examination of the case of Elizabeth Barrett Browning and her dog Flush, he shows the ways in which dog-stealing traded in 'feminine' emotions of affection among the Victorian middle-classes, challenging the safety of domestic space and further reinforcing notions of danger for women (and their pets) in public space.

Whilst emotional connection with animals is often seen as a 'weak' or feminine quality, other types of relationships with animals and nature are implicit in the construction of various masculine identities. The separation of domesticated and undomesticated nature continues to carry forward a seductive notion, implicit in much contemporary environmentalism, that 'nature', to be natural, must be untainted by humans (Cronon 1995). This not only reinforces traditional notions of culture/nature in the present day, but also privileges certain types of undomesticated 'masculine' nature such as big wild animals and mountainous terrain at the expense of 'trivial' 'feminine' nature such as budgies and chickens, which are seen as less worthy of protection and concern.

Jody Emel (1998) discusses the construction of masculinity in the American mid-west in the nineteenth century through the practices of hunting and wolf eradication. Wolves were seen as

contravening the dominant discourses of frontier masculinity, accused of savagery, cowardice, pack hunting and lack of sporting instinct, thus the hunting and killing of such 'fierce' animals was seen as 'deserved' and an expression of virility and manhood. This unnecessarily brutal eradication of wolves was linked to other forms of prejudice and cruelty, including sexism, racism and sadism in the treatment of humans and removal of Native-American people from their lands.

Similarly James Ryan (2000) discusses big game hunting and photography in colonial Africa. Hunting and collecting of 'trophies' was seen as 'exercising all the facilities which make a man more manly' (Peel 1906: 205). Such trophies (be they actual dead animals or photographs showing the hunter posing next to his 'prey') served to construct the colonial imagination of the 'wildness' of Africa, as an untouched part of pristine 'nature'. This added not only to colonial discourses of white men as brave adventurers, but also constructed local people as 'savages' and 'part of nature', thus legitimizing colonial domination of both people and animals. This was further reinforced through the process of domestication (Anderson 1997) and the removal of live animals for exhibit in colonial era zoos, which provided a 'local experience of global nature' and created strong gendered and racialized 'imaginary geographies' of the animals and 'the lands from which they came' (Anderson 1995).

Today animals are also used in the construction of racial as well as gendered discourses. Elder, Wolch and Emel (1998) discuss the ways in which practices of cruelty towards animals are used to racialize and devalue immigrant groups in the USA. Driven by anxiety over declining global hegemony and increased population diversity, dominant groups in the US are waging an intense

battle to maintain their positions of material and political power and protect a particular type of socially constructed national identity. Conflicts over animal practices rooted in deep-seated cultural beliefs and social norms, such as the slitting of animals' throats to produce halal meat, are used to racialize groups of different religions and colour and portray them as 'savages' or 'uncivilized' through their treatment of animals. Similarly, Asian practices of eating dogs are seen as even more socially abhorrent in a society where cultural norms value canines as inedible, almost quasi-human individuals.

Further links can be drawn between gender identities and the practice of meat-eating itself. In her important 1990 book 'The Sexual Politics of Meat' Carol Adams shows how meat has traditionally been considered a 'male' food, with meat eating privileged to men in times of hardship, whilst in times of plenty everyone was expected to consume flesh. Consumption of animal protein has strong symbolic links with masculinity and male strength and virility in a variety of cultures across the world, and particularly amongst the poorest people separate meals may be prepared containing meat for the men, while women and children have to rely upon alternate sources of nutrition. Vegetables, milk, eggs and grains have traditionally been considered 'female' foods, supported to some extent by the disproportionate numbers of male and female vegetarians in contemporary Western societies. Adams also draws parallels between violence towards animals and metaphors of meat such as 'breast' and 'flesh', which are used to justify male sexual violence towards women. Furthermore various studies have shown links between domestic violence against women and animals (Flynn 2000; Holmberg 2004).

Conclusion

The majority of academic study on human-animal relationships is relatively recent, growing from political movements of the late twentieth century against multiple oppressions of sexism, racism and speciesism. While gender and animal studies have a basis in similar political and theoretical ideas, traditionally animals were seen as 'outside' of human culture and thus of the concerns of feminist literature. However, these connections are increasingly being drawn and can be seen to affect human-animal relationships and understandings at all levels of society.

Much interesting work has been carried out on the position of animals in science and culture, as symbols onto which we can project understandings of the human world, as embodied beings in individual human-animal relationships and as actors in the construction of personal, gendered, national or racialized identities. Debates over animal 'agency' or 'rights' raise questions of anthropomorphism and similarities or differences between the human and non-human worlds. The challenge now is to find new ways of thinking about human, animal and gender relationships that do not fall back upon previous dichotomies or essentialized notions of human or animal gender, intelligence or language. This is something that feminist scholars are beginning to do through a focus upon notions of 'relationality' (Haraway 2003; Fox 2005) and 'performativity' (Birke Bryld and Lykke 2004) in order to recognize both the differences and the 'intimate familiarities' (Birke 2002) between a variety of different beings who inhabit the earth. This field is as yet relatively new and hopefully will develop further in the future.

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ANELIS KAISER | Sex/gender[1] and neuroscience: focusing on current research

*Inter*disciplinary point of departure

Before I begin, I would like to stress my perspective on the topic of this article. My point of departure is a hybrid one located between science studies and science. After first being trained as a psychologist, I built up my base of knowledge of "gender" and "sex" simultaneously, the first in a PhD programme in gender studies and the second during empirical implementation of a neuroscientific experiment. This parallel access to the topic of sex/gender in neuroscience shaped my understanding, which I would term *inter*disciplinary. Ever since, I have been trying to open up the specific research field between fMRI neuroscience and gender studies. Rather than focusing on the gap between these disciplines, I have wanted to occupy and fill up a new common space. My purpose was and is to adapt the fMRI experimental ways of dealing with sex/gender to concepts in gender studies and, vice versa, to adjust concepts in gender studies towards an fMRI experimental science that measures sex/gender. Why is this so important to me? First, because the "deconstructed" concept of sex/gender has not yet reached the scientific experimental setting, and there is a need to enable it to do so. Second, we still do not know enough about sex/

1 To highlight the socio-biological closeness and to express the "intermediateness" between discourse and materiality when speaking of women's and men's brains, I will use the double term ***sex/gender*** throughout this article.

gender materialities inside our bodies, for instance in the brain. Thus, the point of view of the present paper will be from somewhere outside of neuroscience, but will still be bound up with certain scientific approaches.

Gender studies indicate that there is no clear-cut distinction between a biological sex and a social gender (Butler 1990; Haraway 1995; Kraus 2000). Although in brain sciences, too, it is becoming increasingly evident that the biological and social components of many brain functions and structures cannot be separated, there is still little discussion or reflection on the materiality of sex/gender in the brain or on how the brain becomes gendered. Unaware of their role in defining or creating sex/gender, neuroscientists persist in publishing "new" insights and establishing facts about the biological nature of the brain as "the most important sexual organ" (Dennis 2004). For instance, a recently published, prominent study in *Nature Reviews Neuroscience* examines the question of why sex matters to neuroscience (Cahill 2006). The author calls for "research into sex … to fully understand brain disorders … with sex differences in their incidence and/or nature" (Cahill 2006: 477). Sex, i.e. sex differences, he argues, are not negligible, and disregarding these differences probably retards progress in the field.

Focusing on a few examples, I will show how neuroscience explicitly and implicitly operates with sex/gender in its empirical research. I am mainly interested in the indirect notions and associations of sex/gender in experimental fMRI science. These notions and associations become real, they take on materiality, during experimentation, i.e. during the neuroscientific experiment itself. I will argue that, during the fMRI experiment, we do sex/gender by means of *measuring*. However, there is potential in empirical brain science, too. The fMRI experiment itself could be the point of

departure for a sex/gender studies-oriented critique of sex/gender biases and heteronormative predictions and conclusions, without the result being that science is made ridiculous – as it is not science itself, but the way in which science is carried out, that should be addressed by feminist and sex/gender-concerned researchers. Rather than attempting a deconstruction of sex/gender, the present article suggests a question that is difficult to ask: Can we take a deconstructed sex/gender seriously, on the one hand, and be committed to scientific explanation, on the other? I will begin with a brief historical and methodological introduction and then move on to a description of selected experimental settings. This description is structured around the following questions: What does the experimental implementation look like? What are the variables measured in the experiment? What do the results show?

The roots of sex/gender in the brain

Research on the brain has a centuries-old history (Hagner 1999). Although not quite as old, the systematic examination of our thinking organ with respect to gender differences can be traced back to 1861. In that year, Paul Broca reported that the female brain was smaller in size than the male brain. He went on to deduce that this difference could be correlated with a difference in intelligence – in favour of men (Broca 1861). At that time and for a long time afterwards, the brain was examined in post-mortem studies: Researchers in direct contact with cortical and subcortical material made comparisons of the male and female brain, for example through quantification of size or weight.

Measuring

In neuroscientific research, *measuring* has always played a central role, and this is also the case for differential examinations of sex/gender. Not only can the entire brain be sized or weighed, but the brain's individual parts can also be subject to measurement. So, in the 1970s and 1980s, the corpus callosum was considered an important location of sex/gender difference. Like a bridge, the corpus callosum connects both halves of the brain along their lengths (see Fig. 1) and is responsible for conveying information from one hemisphere to the other, among other functions. As an example, for this particular brain structure, the measurement of sex/gender differences was and continues to be made of the posterior part, the so-called *splenium*. According to several studies (de Lacoste-Utamsim and Holloway 1982; Dubb et al. 2003), this part turns out to be larger in women. However, other studies are unable to demonstrate this difference (Byne and Bleier 1988; Bishop and Wahlsten 1997). In this context, Fausto-Sterling makes reference to the difficulty of defining this area as a discrete segment, and points critically to the fact that certain structures of the brain only take on significance through measurement (Fausto-Sterling: 115–145).

For many, the measurement of female and male brains for the sole purpose of comparison would not be considered problematic. However, each act of measurement is bound up with particular presuppositions as well as explicit theses. In the example of the splenium, there is the related thesis that, in women, a larger splenium can be understood as a sign of less hemispheric lateralisation or less specialisation. That is, a larger splenium, extending to both hemispheres, would connect them strongly with one another and create a more extensive network between them, whereas a smaller splenium would signify less of a strong connection between the

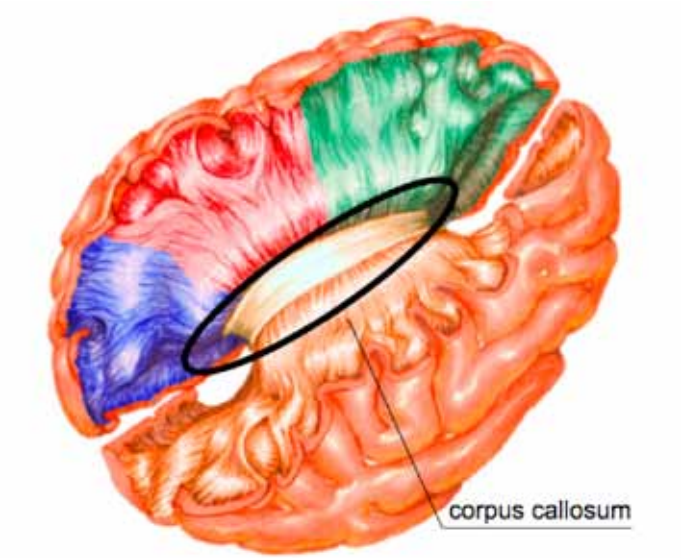

Fig. 1. The brain and its corpus callosum.

hemispheres, enabling a greater degree of specialisation and lateralisation. A smaller splenium in men would thus guarantee better performance in skills correlated with lateralised areas. Such skills include visual-spatial abilities, measured in a majority of the experiments in the above-mentioned studies. Likewise, on account of their spleniums, women would perform worse–at least on visual-spatial tasks. When observed from a more general standpoint, it is noticeable how our social conceptions of women and men–in this case that women have "networking" skills and that men are more "focused"–are reflected in neuroanatomical materialities: We find "networking", i.e. symmetrical brain activation, in women and "focused", i.e. asymmetrical activation, in men. Can this coincidence between social notions and biological brain facticities be considered scientifically verified?

Measuring with fMRI

A measuring technique that has been increasingly implemented in recent years for the examination of brain activity and that has been in existence for about 15 years is *functional Magnetic Resonance Imaging* (fMRI). This method allows a "direct" view into the brain and gives rise to the possibility of observing the brain "at work." One advantage of fMRI is its graphic visualisation of human mental performance (this includes various cognitive processes such as speaking, memory processing, deciding, etc.). fMRI is based on the measurement of fluctuating blood oxygen levels in the strongly magnetic environment of a tomograph (see Fig. 2). Parts of the brain that are intensively involved in a cognitive process need more oxygen than other parts do; these differences, recorded in a magnetic field, can be quantified and thus measured. Complex reconstructions based on mathematic algorithms finally result in the images of the brain, by now familiar to many of us, featuring "colourful spots."

Fig. 2. Magnetic resonance scanner used for fMRI experiments.

Some fMRI experiments on sex/gender differences

Sex/gender differences have been examined since the beginning of fMRI research. In 1995, an examination of human speech showed how men differ from women with respect to an area in the brain known as the inferior frontal gyrus (IFG), which is associated with language processing (Shaywitz et al. 1995). How was this demonstrated? The experiment was structured around three component tasks, in which skills in orthography, phonology, and semantics were measured, respectively. The subdivision of language into linguistic categories in order to make it measurable is common practice; language is operationalised in this way not only in fMRI research, but also in linguistics, psycholinguistics, and cognitive psychology experiments. Shaywitz et al. (1995) showed a sex/gender difference in the phonology task—i.e., a statistically significant difference, detected through the number of activated pixels, was presented in the IFG. This difference was given a particular function in the study: it was incorporated into the title, which speaks in a generalising fashion of "Sex differences in the functional organisation of the brain for language". The other two component tasks, in which no difference was registered, are not granted sufficient importance to be included in the title. Why not? Is it because they show sex/gender similarities?

Besides language processing, other mental operations can also be examined for sex/gender differences. In recent years alone, a whole array of neurocognitive experiments have been carried out in the fMRI landscape on the topic of sex/gender differences. For example, men and women underwent tasks that examined their spatial orientation skills (Jordan et al. 2002) or their planning ability (Boghi et al. 2006), or that recorded their memory performance (Piefke et al. 2005). The number of test subjects in these studies

varied between 18 and 24 in total.[2] These experiments exhibit both significant differences as well as similarities between the sexes/genders in regional brain activation. Therefore, it is important to emphasise that the question of sex/gender differences in higher cognitive processes is a matter of scholarly debate in fMRI research (Schmitz 2006): We find studies that demonstrate such differences and others that do not. Further fMRI experiments on the topic of woman/man include, for example, examinations of olfactory processing (Royet et al. 2003), facial perception (Kranz et al. 2006), emotional sensation (Hofer et al. 2007) – or else, why not, the satiety reaction to chocolate (Smeets et al. 2006). This last study will receive further comment in what follows.

Effect of satiety on brain activation during chocolate tasting in men and women

In order better to understand the mechanisms regulating food intake, it can be important to differentiate between the regulation of food intake in women and in men – or so we read in the introduction to the study of Smeets et al. (Smeets et al. 2006). To this end, "selective satiety" is measured with respect to the consumption of chocolate. Selective satiety is defined as a condition that arises when the motivation to eat more chocolate decreases in relation to the motivation not to eat any more chocolate. During the experimental phase, during which the regional activation of the brain was measured with fMRI, test subjects were administered chocolate and chocolate milk. At that time, various studies had examined the topic of satiety in the brain; in these studies satiety

2 In comparison with psychology studies in general, this sample size is relatively small. Even a sample size of 12 (6 women and 6 men) was not uncommon in 2002 (Rossell et al. 2002). The representativity of results in fMRI research was then and continues to be a source of constant discussion; elaborate statistical corrections are necessary to make results based on a comparatively small sample size conclusive.

had been investigated through the presentation of visual (LaBar et al. 2001), olfactory (O'Doherty et al. 2000), or taste-related stimuli (Small et al. 2001), to name a few examples. Anyway, Smeet et al.'s work was the first fMRI study dedicated to selective satiety during the eating of chocolate with especial regard to possible sex/gender differences.

The results show differences between women and men in several areas of the brain, for example in the orbitofrontal cortex, in the amgydala, and in the hypothalamus (1–3).

(1) The orbitofrontal cortex is located in the anterior part of the brain. Here, men show an increase in activation, whereas for women, no increase in regional activation resulting from satiety with regard to chocolate can be found.

(2) Another area where a difference was found is the amygdala (see Fig. 3). The amygdala is part of the limbic system and plays an essential role in memory processing and emotional reactions. In women, decreased activation in this area was detected; men show no change in activation here. According to the authors, this last outcome corresponds to the results of previous research. More specifically, earlier studies showed that the pleasant taste of a food is less significant during a feeling of satiety as it is during the condition of hunger (LaBar et al. 2001). The lesser significance of the pleasant taste of a food, in this case chocolate, during selective satiety is reflected in the decreased regional activation in the brain, or so we read.

Is it any coincidence that in this study of satiety, change in activation is found in men, among other areas, in the orbitofrontal region of the brain — a location of higher thought processes — whereas in women, changes in activation are found, among other regions, in the amygdala, an area associated with emotions?

(3) The hypothalamus also showed dissimilarities between women and men. Here, men demonstrated no change in regional activation while women showed a decrease. The hypothalamus is a structure of the brain responsible for maintenance and coordination of breathing, circulation, food intake, body temperature, and reproductive processes, among other functions. According to Smeets et al., the decrease in activation found here in women test subjects could be correlated with the decrease in the feeling (of hunger) that accompanies selective satiety. This parallel, i.e. the correspondence of a decrease in the feeling of hunger and a decrease in the regional activation of the brain, is not generally observable. Decreased, lessened, or slower (re)actions or activity on the behavioural and physiological level can also signify an increase in regional activation in the brain, and vice versa. However, does this hypothalamic result showed here involve the implicit statement that women are more consistent in terms of what they feel, on the outside, and what they reflect neuroanatomically, on the inside? For once, no gender stereotype!

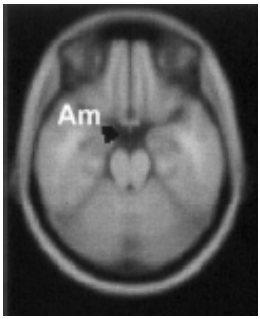

Fig. 3. From Smeets et al. (2006: 1302). Group activation of women: the black mark depicts activation in the amygdala.

Incidentally, the reason why recourse is being made to chocolate, specifically, is never explained in this study. It may have some-

thing to do with the fact that the paper appears in *The American Journal of Clinical Nutrition*, for whose readership it is customary to exploratively examine food sources. But what would happen if we tested all food sources for sex/gender difference? Would we then learn that men and women also demonstrate local differences in the brain during the intake of bread or water? And would that mean anything for our general water-drinking and bread-eating behaviour?

Measuring sexual arousal and sexual orientation

Another area of research using fMRI experimentation that implicitly and explicitly codetermines sex/gender in neuroscience involves work on human sexuality or sexual arousal as well as work on sexual orientation. As opposed to the studies introduced above, in these studies sex/gender is more closely linked with the examined variable, as sexual arousal and sexual orientation are more directly related to sex/gender designation than are, for example, satiety, speech, or spatial orientation.

Sexual arousal

There is a wide array of fMRI experiments that investigate sexual arousal in the broadest sense. Many of them are based on sample populations that consist exclusively of men. Some of their titles include "Brain processing of visual sexual stimuli in healthy men: a functional magnetic resonance imaging study" (Mouras et al. 2004), "Brain activation and sexual arousal in healthy, heterosexual males" (Arnow et al. 2002), or "Brain activation during human male ejaculation" (Holstege et al. 2003). Studies examining sexual arousal in both men and women are much less common (Karama et al. 2002; Hamann et al. 2004). Until now, there has

been only one study devoted exclusively to the sexual arousal of healthy women (Park et al. 2001), while another study focuses on the different phases of the menstrual cycle in connection with the sexual arousability of the test subjects (Gizewski et al. 2006). Concerning the latter study, I wonder, why are women linked to their biological reproductive rhythm when their sexual responsiveness is under examination?

Sexual activation is measured in the brain by recording brain activity brought on during sexual arousal or physical sexual engagement. This sexual brain activity is understood as a subjective response to sexual desire. As a rule, experiments are designed according to the following pattern: test subjects are presented with visual stimuli in the form of erotic pictures, short clips or videos, which serve the purpose of inducing in the participants a state of sexual arousal. The studies that trace activation in men's brains during orgasm entail the help of female partners or else the manual skills of the test subjects. Even more uncommon than the examination of sexual arousal in women is the investigation of the female orgasm: The healthy female orgasm has not yet been studied with fMRI, although orgasm has been studied among depressed women (Yang et al. 2008) and women diagnosed with complete spinal cord injury (Komisaruk and Whipple 2005). Does this possibly tell us that women must first exhibit problems with this aspect of their sexuality in order to become a part of fMRI research?

The comparative study of heterosexual women and heterosexual men conducted by Hamann et al. (2004) is based on the presentation of three types of erotic pictures: heterosexual pairs during explicit sexual activity, nude photographs of attractive models of the opposite sex, and depictions of social interaction

with negligible sexual connotations. The results of this study show a greater activation in men in comparison to women in the amygdala and hypothalamus during the observation of identical stimuli. This was the case although women reported greater sexual arousal. Men showing more activation on the biological level and women demonstrating a greater response on the level of feelings ... A coincidence?

In this and similar experiments in which sexual arousal is measured, many implicit and explicit statements are made about what sex/gender is, what a man is and what a woman is. Seemingly neutral neuroscientific knowledge, the product of "objective" processes of measurement, is procured and organised through a binary gender logic, according to which the detection of differences is more important than the detection of similarities. There is little room for anything besides "female" and "male" brain activation. A queer neuroscience is scarcely conceivable at the present time, although lesbian, gay, and transgender people or their brains have been an interesting "object" of examination for quite a long time. To conclude, the following will present an excursus of a PET[3] study that takes on differing activation in the brains of homosexual and heterosexual men (see fig. 4). In this way, the question will be raised as to how homosexuality becomes a measurable neurological matter.

Sexual orientation

The main purpose of studies such as "Differential brain activation in exclusively homosexual and heterosexual men" (Kinnunen at al. 2004) is primarily to collect data on differences between

3 PET (positron emission tomography), like fMRI, is an imaging procedure used, for instance, to depict regional activations in the brain.

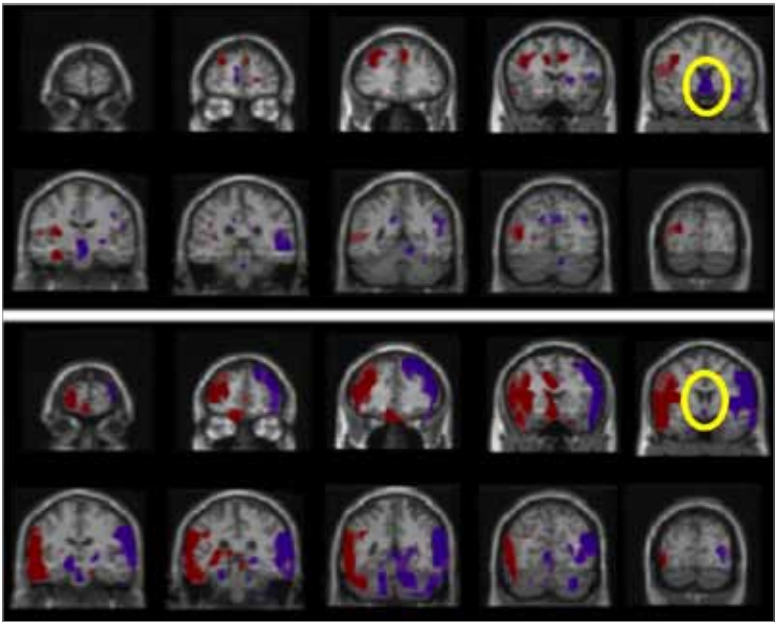

Fig. 4: From Kinnunen at al. (2004: 252). Brains of homosexual men (below) and heterosexual men (above).

gay and straight people – although these experiments are mostly concerned with men. Again, the experiments vary widely in their implementations.

These pictures show brain activation in homosexual men (below) and heterosexual men (above) after the injection of a pharmacological substance that influences the brain's transmitter system in a certain way. The authors focus on the difference between homosexual and heterosexual men in a specific area of the brain, the medial preoptic area of the anterior hypothalamus (mPOA). From animal experiments we know that the mPOA is "critical for the expression of sexual behaviour in male animals" (Kinnuen et

al. 2004: 251). In linking this specific area and this specific reaction of the transmitter system with a specific sexual preference, one runs the risk of drawing a deterministic conclusion along the lines of "from the genes to behaviour". In this study, it is little wonder that the authors would detect a difference in the hypothalamus (encircled) in the two categories of test subjects; indeed, under these experimental conditions, gay men showed more hypothalamic activation than heterosexuals did. In this picture we see more than just hypothalamic activation, but these other activated areas are apparently less significant, or else they would have been integrated into the main hypothesis of the study. There is, for instance, regional activation in the frontal lobe. Why is it considered less important? Is it because the frontal cortex is related to thinking, executing and planning and not to drives, as is the hypothalamus? And why is the question of homosexuality being linked to these areas related to drives? Furthermore, it would have been possible to emphasise the abundant similarities in the activation patterns. After all, the coloured dispersion is almost the same, i.e. when there is a red activation in the homosexual group, there is a red activation around this area in the heterosexual group, too. No red activation in a certain area in the gay group is purple in the straight group.[4]

Finally, even if there were a difference in activation between homosexual and heterosexual men, this difference would not necessarily be attributable as the cause of a certain way of living and forming relationships; it could also be regarded as the result.

Regarding brain activation as a result of previous life or as a result of socialisation is an approach that can be partly seen as in line

4 Red colour means an increase in activation in response to the injection of the pharmacological substance, purple colour means a decrease.

with contemporary brain research. In this context, some neuroscientists argue for cerebral *plasticity* (Jäncke et al. 2001, Draganski et al. 2004), referring to the crucial role of experience not only for the development of our brains, but also for any further influence during adulthood. That is how *learning* becomes central to the biology of our thinking organ. For this article, the concept of plasticity can help in understanding the inseparability of the biological and social facets of sex/gender in our brains.

My own research

Before concluding, I would like to present some results of my own research. Our study focuses on sex/gender and language in fMRI research. We explore the question of similarities and differences in 22 men and 22 women, respectively, in a language production task (Kaiser et al. 2007).

Parts of the results show, in women, a left-lateralised activation in BA 44, and in men, a more often bilateral and more frontal activation in BA 45.[5] This result is opposite to most results shown in language experiments so far, in which bilateral patterns were shown in women and lateral patterns in men. Based on this result, we argue that the sex/gender differences in the brain should be regarded much more critically, due to numerous variables interacting and thus becoming confused with sex/gender. Our study, too, cannot resolve the controversy concerning the existence of sex/gender similarities and differences in fMRI-language investigations. In this study, we still operate with a binary sex/gender, though showing a reverse sex/gender pattern may relativise the fixation on bilateralising women's brains and lateralising men's brains in fMRI-language studies. This result is in line

5 Brodmann's area 44 and Brodmann's area 45 are "language areas" in the brain.

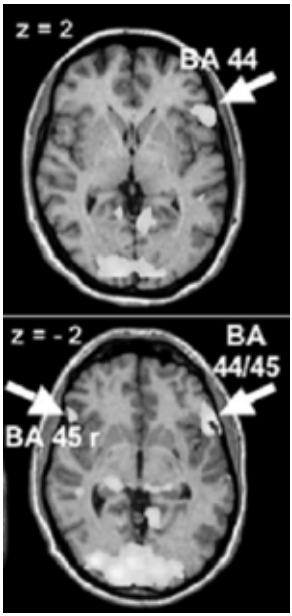

Fig. 5 From Kaiser et al. (2007): Women's lateral and men's bilateral activation.

with the work of feminist scientists operating within a scientific frame, whose objective it has been to disequilibrate expected sex/gender-related results in the brain. See, for instance, Ruth Bleier's study showing that variations in the human corpus callosum do not predict gender (1988).

Visions

The various areas of research to which the examined studies belong indicate widespread interest in the variable of sex/gender, as the various aspects brought under criticism demonstrate the many interactions of research with innerscientific contingencies, binary constellations, and conceptions of sex/gender. The present article was intended to give a critical insight into neuroscientific research on the topic of sex/gender. Points of emphasis were selected in

reference to one of many measurement techniques, that of fMRI. I was mainly interested in the implicit and explicit notions and associations of sex/gender in fMRI experiments, and I hope to have shown what it means for empirically experimental science to engage with, or even to *measure* sex/gender. While many of the pitfalls of sex/gender research in fMRI science have been stressed throughout this article, the main potential of such research should not be left unconsidered. Paradoxically, the most significant advantage lies in the experiment itself. In my mind, it is absolutely crucial to analyse intensively the paradigms and implementations of the experimental neuroscientific setting if we are to take a step that has not yet been taken in sex/gender research. Several studies from a deconstructive or discourse-analytical perspective have already dedicated part or all of their attention to the topic of "gender and the biological sciences". This is as it should be, but the matter should not be allowed to rest there. The experiment is the moment when new conceptions of sex/gender can be transformed into a new measurable and concrete research materiality. An appropriate, or more appropriate, implementation of sex/gender in fMRI research is possible, for instance one that disequilibrates expected sex/gender-related brain activations, or one that stresses the brain's plasticity – or a still more visionary one that makes the many sexes/genders visible in the brain.

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ANNA T. HÖGLUND | Gender and Bioethics

Introduction

Bioethics is a constantly growing research area. For several decades, new advances have brought the field forward. Bioethics can be defined as the study and formulation of the ethics of health care and life sciences. Today, it is not unusual to include also ethics with regard to animals and the environment in the definition. In this presentation, however, a more limited definition will be used, namely that "bioethics takes on ethical problems raised by health and health care" (Wolf 1996:7). This means that the field includes both clinical ethics and research ethics, as well as questions of social ethics relevant to the topic, such as the allocation of resources in health care politics. Bioethics is a clearly interdisciplinary field, including studies in, for example, philosophy, law, theology, and sociology.

The main task for bioethicists has always been to protect vulnerable patients and research subjects from harm and abuses. Likewise, the legal and moral rights of patients and research subjects have also been at the core of this tradition. In spite of this, neither gender nor ethnicity or class has received a great deal of attention within bioethics. In the present article, I intend to discuss and analyse the reasons why this is the case. Through my analysis, it will be made clear that the neglecting of gender is not a coincidence, nor is it a paradox, but rather a consequence of cer-

tain basic assumptions within mainstream bioethics. Further, the article will present an example of how a gender perspective might impact bioethics, both concerning research topics and theoretical assumptions.

Gender and Health Care

One well-established definition states that gender theory concerns cultural conceptions of masculinity and femininity as well as power relations between women and men. Further, it deals with the construction of identity for individual men and women related to cultural gender norms. In accord with, for example, R. W. Connell, I define gender as a structure of social practice – social practice that constantly refers to bodies, but that is not reduced to the body. The body is "the reproductive arena" for gender construction, but not, as Connell puts it, the biological base for gender shaping (Connell 1995:71, 81).

In this paper, gender will be used as a concept distinguished from biological sex, but without separating the two phenomena completely. Further, the perspective is on "doing gender", meaning that we are all constantly involved in a process where we construct and constitute our gender identity (see, e.g., Hirdman 2001). This process is relevant in our private as well as our public lives, which means that it is present also in the encounter between the patient and the health care provider, as well as in the construction of professional identity for, among others, doctors and nurses. Further, I adhere to the tradition that sees gender as a pluralistic and constructed phenomenon as well as a category that intersects with other factors in the identity construction of individuals and groups, such as age, ethnicity, social class and sexual orientation:

> Because gender is a way of structuring social practice in general, not a special type of practice, it is unavoidably involved with other social structures. It is now common to say that gender 'intersects' – better, interacts – with race and class. We might add that it constantly interacts with nationality or position in the world order (Connell 1995:75).

In the past decades, several studies have reported gender inequalities in health and health care. Investigations in both Sweden and other Western countries have revealed that the allocation of resources in the health care sector is biased. Although the Swedish Health and Medical Services Act (SFS 1982:763) states that the goal of the Swedish health care system is equal health for the whole population, some groups tend to be suffering from injustice in both health and health care, such as women, immigrants and elderly people.

This is obvious in many ways. First, it has been shown that men get a doctor's appointment more easily than women do, and they are also more likely to get expensive medicines (Smirthwaite 2007). Likewise, it has been reported that women are less prioritized in health care and that certain diagnoses, such as depression and myocardial infarction, are so gendered that men with depression symptoms and women with signs of myocardial infarction initially receive incorrect diagnoses and therefore risk mistreatment (ibid.). Furthermore, studies have reported that clinical trials are biased in relation to gender, but also with reference to ethnicity and age, which might result in deficient knowledge on diseases typical for, e.g., women and the elderly (Söderström 2004:108).

It has also been reported that there are gender-related patterns in people's health care behaviour. For example, women tend to seek health care more actively than men do, and they are also more eager to contact health care services on behalf of others, not least their children and husbands (Kraemer 2000; Höglund & Holmström 2008). Finally, the encounter between the health care giver and the patient is also impacted by gender (Johansson & Hamberg 2004:117-122). In light of the historical fact that doctors traditionally were men, one might suggest, as Susan Wolf did, that "the paradigmatic medical encounter has involved a woman needing care going to a professional man" (Wolf 1996:11).

These are examples of gender inequalities and gender-based patterns in health care and they all raise ethical question; questions of patients' rights, of justice in health and health care and of treating every person as an end in itself. Yet gender and other identity constituting factors, such as age, ethnicity and class, have not received a great deal of attention within bioethics. This is even more difficult to understand in light of all the interest bioethicists have shown in questions concerning reproduction. Wolf describes this situation as follows:

> Most of the quandaries that occupy modern bioethics, from reproductive technologies and genetic screening to the HIV epidemic and the allocation of health care resources, have distinct implications for women and men (Wolf 1996:4).

Considering the fact that the main task for bioethics, as set out by ethicists and practitioners themselves, is the protection of vulnerable patients and research subjects, and that this is the basic value that should guide the ethics of physicians and nurses, it is even

more remarkable that factors such as gender, age and ethnicity have been so overlooked in this tradition. So let us turn to the first question in the present article, namely, why gender has not received more attention within the field of bioethics.

The Lack of Gender Perspectives in Bioethics

Ethics has always been an important aspect of medical practice, from the development of the Hippocratic Oath in Ancient Greece until today. At the same time, one could say that the starting point for modern bioethics is the Nuremberg trials, which took place soon after the Second World War. As a guarantee that the atrocities committed against Jews and other prisoners in the German concentration camps would not be repeated, a code of ethics was set up. In this code, the Nuremburg Code from 1949, rules for research on human subjects were prescribed, primarily that no studies must be done without the patient's informed consent (Shamoo & Resnik 2003:197).

Also, medical research ethics advanced due to events such as the so-called Tuskegee scandal, in which it was revealed in 1972 that illiterate, poor African American males with syphilis had been used as research subjects without their own knowledge for a period of nearly 40 years. The aim of the investigation was to study the spontaneous development of syphilis, and the available treatment was thus also withheld from the research subjects (Shamoo & Resnik 2003:187). These abuses resulted in the construction of a National Commission, which presented the so-called Belmont Report in 1979. In this report ethical principles were suggested to guide all research on human subjects, e.g., the principle of respect for persons, the principle of beneficence and the principle of justice (Shamoo & Resnik 2003:196–197). Despite both these foun-

dational events for bioethics, in which race and ethnicity played such an important part, neither these categories nor gender has received special attention in bioethics.

It is also important to point out that the academic work on bioethics developed alongside the women's movement and the civil rights movement in the 1960s and 1970s in the US (Wolf 1996:13). Still, these efforts did not influence bioethics, either. Laura Purdy has pointed out how the field of bioethics has essentially ignored academic work that uses gender as an analytic tool (Purdy 1992:12). According to, among others, Helen Bequaert Holmes, the reason for this lack of interest in aspects like gender and ethnicity is to be found in the nature of the field itself. She identifies several aspects that she holds are the primary causes of the "gap" between gender and bioethics, namely *abstraction* (meaning that bioethics draws heavily upon principle-based reasoning instead of particularism and contextualism); *individualism and autonomy* (meaning that bioethics embraces liberal individualism and hence obscures the importance of groups); *unawareness of social movements* (such as the women's health movement); *unexamined assumptions* (for example, concerning the focus upon individualism and principlism); *a crisis orientation* (meaning that bioethics seems to focus upon medical emergencies); and, finally, *a false dualism* (meaning that bioethics is concerned with right or wrong doing, with questions such as: Resuscitate or not? Terminate pregnancy or not?) (Bequaert Holmes 1999:53–54).

I consider that, among these suggestions, primarily two aspects can theoretically explain the lack of gender perspectives in the bioethics tradition, namely *the dominance of principles* and *the in-*

fluence of liberal individualism. These are also closely related to what Bequaert Holmes refers to as "unexamined assumptions". I will briefly comment upon these two identified obstacles.

The Dominance of Principles

It has been argued that bioethicists seem to pay special attraction to principlism (Evans 2000). The most influential example of this is the well-established ethical principles formulated by Tom Beauchamp and James Childress. In the 1970s, they suggested four ethical principles intended to guide all medical practice, namely *the principle of autonomy*, *the principle of non-maleficence*, *the principle of beneficence* "and" *the principle of justice.* The principles are deliberately open and broad and are not placed in order of precedence. On the contrary, they are to be used alternately, applied to the specific situation. In ethical dilemmas – i.e., when there are conflicting interests, values or responsibilities – in following one guiding principle, one deserts another. The desertion of one ethical demand can be justified with reference to another (Beauchamp & Childress 2001).

The four principles are developed through both consequence-based (utilitarian) and obligation-based (deontological) ethical theory. The principles of non-maleficence and beneficence are utilitarian in character, meaning that in an ethical dilemma one should strive to maximize the good consequences and minimize the risks. The principles of autonomy and justice are derived from deontological reasoning, meaning that the moral agent has a duty to respect human dignity in every person as well as to treat all individuals as equals, regardless of the consequences of their actions (ibid.).

Principle-based moral arguing is an example of a top-down approach to ethics. Further, ethical principles are often governed by requirements of universality, impartiality and an assumption of an abstract and independent moral agent (Rachels 2007). Researchers working from a gender perspective have criticized this approach to ethics in several ways. The starting point for this criticism was the work of psychologist Carol Gilligan, first published in 1982.

Based on empirical investigations of women's and men's moral development, Gilligan argued that the standardized moral voice is characterized by justice and rights. The prime moral norm is that every person should be treated equally. In her study, this was the position men and boys took. Moral judgments in this tradition were based on abstract and universal moral principles and an assumption of mutual non-involvement. The different voice in Gilligan's material, which also turned out to be the female one, on the other hand, was characterized by context sensitivity, particularity, responsibility and care. The moral imperative in this tradition is to secure that no one is harmed (Gilligan 1993).

Building on Gilligan's empirical results, the feminist philosopher Nel Noddings developed a normative ethic of care in her book *Caring*, first published in 1984. Her work is a firm critique of principle-based ethics, holding that it is an ethics based on male experience and an abstract view of the moral subject (Noddings 1984). Although Noddings presents strong and interesting critique against the principle-based ethics that has dominated bioethics, and in spite of how she reveals this tradition's connection to gender, an ethic of care also raises gender problems. Alisa Carse and Hilde Lindemann Nelson argue:

> The ethics of care validates skills and virtues traditionally associated with women and women's roles. This presents feminists in particular with a dilemma. On the one hand, there is a vital need for an ethic that takes the experiences of women seriously /---/. On the other hand, the ethic threatens to support and sustain the subordinated status of women in society, contributing to the exploitation and denigration of women with which feminist ethics is more broadly concerned (Carse & Lindemann Nelson 1999:17).

Principlism also implies a deductive system in which principles should be applied to specific cases. Drawing on Rawls' theory of a 'reflective equlibrium' (Rawls 1976), ethicists working with gender theory have argued that moral reasoning instead can be seen as a two-way process: bottom-up as well as top-down. By going back and forth between the general principle and the specific case, a reasonable judgement is finally reached, i.e., reflective equilibrium is achieved (Wolf 2006:27).[1] Thereby it is also possible to argue that principles can be drawn from experience, but that they can at the same time influence moral action and in that way contribute to our shaping of experience (Cook 1994).

Apart from this, gender theorists have also explored how the four principles can be revised through gender theory. For example, the principle of autonomy has been thoroughly worked through from a gender perspective (Mackenzie & Stoljar 2000; see further below), and Iris Marion Young (1990) and Susan Moller Okin (1989) have provided interesting examples of how the principle of justice can be revised through a gender perspective.

1 Such a reflective position is also alluded to by Tom Beauchamp and James Childress in the forth edition of their book; see Beauchamp & Childress, 2001.

The Influence of Liberal Individualism

When studying bioethics, be it theories or codes and guidelines, it becomes quite obvious that this tradition is greatly influenced by Kantian philosophy and its basic assumption that every individual must be treated as an end in itself, and not merely as a means to something else (see, e.g., Rachels 2007). Likewise, a basic assumption is that the individual is entitled to self-rule or autonomy (Wolf 1996:16). This focus on the individual person is based on a certain view on the moral subject, namely, that it is an agent that is independent and rational. Reneé Fox and Judith Swazey state that "it is the individual, seen as an autonomous, self-determining entity, rather than in relationship to significant others, that is the starting point and the foundation stone of American bioethics" (Fox & Swazey 1984:339); an observation that applies to bioethics in all Western countries, I would like to add.

From an ethical point of view, the focus on the individual could be important, as it emphasizes every person's right to autonomy and integrity. But the strong individualism within bioethics can also raise ethical questions, primarily concerning justice and fairness. Without paying attention to groups, the fact that certain individuals are not able to exercise their individual rights, due to structural factors that determine group marginalization, may be obscured. Helen Bequaert Holmes argues:

> To be sure, feminists have struggled for women's right to self-determination; we want each and every woman to be treated as a full person. But if we look only at individual rights, then we may not see the groups to which such individuals belong. /---/ But certain groups are marginalized, so that any member of that group, so labelled, also gets marginalized. If we focus on individual rights, groups remain marginalized; in fact, such approaches in bioethics may exacerbate group marginalization (Bequaert Holmes 1999:54).

As pointed out by Young (1994), there are certain harms and wrongs that will only be observed if one considers groups, namely, those that depend upon structural inequalities. According to Young, liberal individualism can hide existing oppression, for example, injustices in the form of excluding mechanisms and collective negative experiences. She writes about the need for feminists to adhere to the notion of women as a group, but her position could also be applied to other groups in society, constituted by phenomena such as ethnicity, age or social class: "Without conceptualising women as a group in some sense, it is not possible to conceptualise oppression as a systematic, structured, institutional process" (Young 1994:718).

Here, of course, the question arises: What constitutes a group in a society? Drawing on the theories developed by Young, I define a social group not simply as a collection of people, but rather as "a specific kind of collectivity, with specific consequences for how people understand one another and themselves" (Young 1990:43). In this view, groups are an expression of social relations, as a group only exists in relation to at least one other group. Further, a social group is defined not by a set of shared attributes, but rather through a sense of affinity. Individuals constitute groups, but

groups also constitute individuals. This does not imply that there is a common nature that all the members of a group share; groups are fluid and heterogeneous. Further, in our complex and differentiated societies, all persons have multiple group identifications (Young 1990:42-48). Still, paying attention to groups is essential in the work for justice and equality. Further, the suggested group definition in itself includes a critique against liberal individualism. In Young's words:

> This view of group differentiation as multiple, cross-cutting, fluid, and shifting implies another critique of the model of the autonomous, unified self. /---/ [I]ndividual persons, as constituted partly by their group affinities and relations, cannot be unified, themselves are heterogeneous and not necessarily coherent (Young 1990:48).

The focus on the individual can explain much of the above-mentioned inequalities in health care, such as the lack of research on women and people of colour and the mistreatment of women with myocardial infarction symptoms. It has obviously been assumed that the principles developed in bioethics, prescribing the patient's right to autonomy and justice, apply equally to all and that they thereby safeguard the situation for every patient. The reported inequalities in health care show, however, that they do not apply equally and that attention to groups, based on factors such as gender or ethnicity, is needed.

It is also obvious that principlism and liberal individualism are closely connected and interdependent, which becomes particularly clear if one studies the principle of autonomy. Autonomy has traditionally been the flagship of bioethics. The opposite of autonomy is paternalism. Given the fact that studies have shown

that women tend to seek health care to a larger extent than men do, and that the doctor historically and traditionally has been a man, one could state that:

> When bioethics has complained of physician 'paternalism', the term could have been construed in its literal, gendered sense: the physician dominating and deciding as a father would (Wolf 1996:11).

As an attempt to criticize both the emphasis on principles and the influence of liberal individualism in bioethics, gender theorists have developed the principle of autonomy from a gender perspective, arguing for a broader notion of the concept. One example is Diana Meyers (1989), who rejects the view that "achieving autonomy is a private project of a liberated, self-monitoring inner self" (Boetzkes 1999:123). Instead she argues that achieving autonomy is a cooperative venture, based on the argument that selves are socially and relationally constructed – a position that sometimes is described as *relational autonomy* (Mackenzie & Stoljar 2000). In these theoretical advances, liberal individualism is questioned not solely as it has been described above through an emphasis on groups, but also through a revised view of the moral subject, as an agent that is embodied, situated and related to other human beings. Further, autonomy is seen as a concept that is achieved in relation to others.

Bringing Gender Theory into the Field of Bioethics

From a gender perspective, it is reasonable to argue that a thorough moral analysis of medical practice and science requires attention to gender as it concerns questions of justice, equality and human dignity. Gendered bioethics – or feminist bioethics which

is the more common term in the literature concerning this kind of research – is part of a greater body of gender analysis work of several academic disciplines, all characterized by approaches that strive to uncover gender biases in traditional science and challenge its assumed impartiality and universal claims. In accord with other feminist bioethicists, I argue that a gender perspective on bioethics would impact several factors, such as the choices of research topics, theoretical analyses and epistemology of the work.

Concerning the range of research questions a gendered bioethics might include, Susan Sherwin has argued that women's experiences of health care and science comprise a set of problems that need new prominence (Sherwin 1992:179–240; 1998:189–252). A feminist approach to these questions would mean seeing the problems in the context of gender and power and not in isolation. The fact that certain diagnoses have been gendered and female life events medicalized are also examples of topics a feminist bioethics might observe. Likewise, the exclusion of women from clinical trials is a subject of research for feminist bioethicists (ibid.).

In the 1990s and at the beginning of the 2000s, considerable interest was directed towards reproductive ethics, including stem cell research. As Suzanne Holland has argued, a gender perspective is important in the human embryonic stem cell debate, as women have a central part in it as oocyte donors; a fact that is often obscured in the debate (Holland 2001:81). Further, one might add that mainstream bioethics has focused upon medical emergencies. A gender perspective would give room also for research on the day-to-day ethics of health care providers (Bequaert Holmes 1999:55).

When it comes to epistemology, early advances in gendered bioethics embraced a standpoint theory, claiming that women as

a group view moral problems differently than men do (Harding 1986; Gilligan 1993). In the 1990s, theories of situated knowledges were brought to the fore (Haraway 1988; Benhabib 1992), which influenced feminist bioethics at the time. In the 1990s and the beginning of the 2000s, several attempts to apply a postmodern gender perspective to bioethics were presented. In her book *Leaky bodies and Boundaries: Feminism, Postmodernism and (Bio)ethics*, Margrit Shildrik (1997) argues that the boundaries of both the subject and the body are no longer fixed, but rather fluid and shifting. Together with Roxanne Mykitiuk, Shildrik is also the editor of *Ethics of the Body*, from 2005, in which the binary thinking of traditional bioethics is criticized and the conventional normative framework of bioethics is called into question through a feminist and postmodern analysis (Shildrik & Mykitiuk 2005).

A common feature of the view of epistemology in current feminist bioethics is the emphasis upon context and particularity, as well as the challenging of universality and impartiality. Gendered bioethics includes critical analyses of the perspectives and agenda behind the process of identifying and describing bioethical problems. "Feminist epistemologies investigate the relationship between power, gender, and the means of generating authoritative knowledge," as Susan Wolf (1996:25) puts it.

Finally, a gender perspective on bioethics would also imply a different approach to analysis and methodology compared to mainstream bioethics. It would embrace a rich empiricism, of which empirical ethics can serve as an example. In the past few years, it has been argued that empirical research can and must play an important role in applied ethics (Holm 2003). Certainly, the bioethical literature is full of references to patient examples and medical cases, but this is not the same as working with empiri-

cal data and empirical methods. The characteristics of empirical ethics are that it is not just another name for descriptive ethics, but rather that it is a form of ethics that aims to be both descriptive and normative. This means, that it can deliver a description and analysis of the actual conduct of a group regarding a morally relevant issue, help identify relevant moral issues in a specific context, and reveal moral opinions and reasons for the patterns of those involved in a certain practice, but also, based upon these descriptions, deliver normative arguments on how ethical dilemmas in the studied context might be tackled (Musschenga 2005). From a gender perspective such an approach is most interesting. Empirical ethics can help reveal the moral reasoning of different groups in health care, e.g., doctors, nurses and patients, and relate it to gender.

Bioethics from a Gender Perspective – An Example

I will close with an example from my own research, showing how a gender perspective might influence both subject and method, as well as theory within bioethics. The example concerns a study on priority setting and the allocation of resources in Swedish health care (Höglund 2005), and is thus an example of what Bequaert Holmes (1999) refers to as the day-to-day ethics for health care providers, apart from medical emergencies.

During the past decade, the Swedish health care system has undergone radical economic and structural changes. Combined with biomedical advances, severe changes have been brought into medical practice. The health care system is today a very complex structure, where ethics has increasingly become a required component. As a result, the demands have entailed that first-line professionals, such as doctors, nurses and auxiliary nurses, must make difficult

ethical judgments in their everyday work. Not only should they consider what is best for their patients, but also consider questions of social economics. In other words, health care professionals on different levels are forced to make decisions concerning priority setting in their day-to-day clinical practice (Kälvemark et al. 2004).

Prioritizing means ranking patients in a certain order or giving precedence. Priority setting in health care concerns making choices about the allocation of resources between competing demands, when perceived need or demand exceeds available assets. In an economic context of increasing demands and constrained resources for health care, an ethical dilemma arises, namely one of balancing respect for human dignity and the rights of individuals with the utility and benefit to society as a whole.

The need for well-informed priorities in health care has increased since the 1990s in several industrialized countries, including Sweden. This development is dependent on different factors. First, the advanced competence in biotechnology has increased the expectations of health care. Second, we are today facing a tendency towards demographic changes, in which an increasing number of elderly people are expected to make use of a greater amount of the health care resources. Finally, there is a political and economical tendency in society towards increasing demands and diminishing allocations for health care.

In 1995, a parliamentary commission suggested a national framework for prioritization in Sweden. An ethical platform consisting of three ethical principles aiming to inform priority setting on the national, political and clinical level was established. The principles were identified in descending order of importance. These were *the principle of human dignity, the principle of need* "and" *solidarity and the principle of cost-efficiency* (SOU 1995:5).

The platform was adopted by the Swedish Parliament and inscribed in the Swedish Health and Medical Services Act. As we can see, this commission adhered strongly to mainstream bioethics and its tradition of principlism.

According to the ethical platform, factors such as gender, age or ethnicity are not valid grounds for priority setting, as they would violate the principle of human dignity. According to the platform, rationing in health care should be on the basis of assessed individual physiological ability to benefit from the treatment and not on the basis of, e.g., age, gender, skin colour, or social position.

According to several sources, however, there is a growing conflict between the ageing of the population and the allocations available to provide good medical care (Lindemann Nelson & Nelson 1996; Tonks 1999). These circumstances also have gender implications; any suggestion of limiting older people's access to expensive medical care ought to be considered in light of the fact that women constitute the majority of the elderly population (Sherwin 1998:17; Bell 1989). The greater longevity of women than men is today well documented and has even increased during the twentieth century. We can thus talk of a feminization of later life. This means that women are more likely to experience widowhood, but also that they are more likely to live in institutional settings during the last stage of life. This also implies that older women are more sensitive and vulnerable to unjust priorities in health care than older men are.

In order to investigate whether gender, age and ethnicity influence priority decisions on the clinical level – in spite of the ethical guidelines accepted by the Swedish parliament – a qualitative study was performed. A strategic sample of doctors, nurses and auxiliary nurses were asked to participate in openly conducted

in-depth interviews. All in all, nine informants were interviewed. Each interview lasted for about one and a half hours. The interviews were recorded and transcribed verbatim and processed as text. Thereafter, they were analysed using a thematic stepwise analysis method as outlined by Malterud (1998).

According to the results, the informants were not highly familiar with the national guidelines for prioritization, but claimed that they had a high moral competence and that they knew what ethical decisions to make, even though they could not describe how they knew this or why. However, the results show that this only holds true to a certain extent. This was made clear particularly when the interviews turned to the question of age-based priority decisions. Some of the informants argued that, in some cases, age could be a relevant factor in priority setting:

> Chronological age matters when you start to think about it. A person in her 50s is treated until the very end, no matter how absurd it may seem from an objective point of view. I think we do that. (Doctor)

> A lot of effort is made to save a younger person's life. I mean, a young person should get more resources – she has her whole life in front of her. (Doctor)

As mentioned above, this is not in accord with the Swedish guidelines for priority setting. Apparently, it was mostly doctors among the informants who accepted age as a relevant factor in priority setting. Nurses and auxiliary nurses all distanced themselves from using age as a factor to guide priority setting in health care:

> Everyone is treated with the respect that every human being is entitled to. I think that's consistent. (Auxiliary nurse)

According to this informant, however, this is not always the case for doctors:

> You asked me if we discriminate between older and younger patients, and I said no. But maybe that's not correct because doctors, I think – not all doctors but several of them – do discriminate. They don't rush things so much when it is a very old person, they just say: "Well, let's give pain alleviation." But if the patient had been 30 years old they would have operated directly. Do you see the difference? (Auxiliary nurse)

This picture was more or less confirmed in the interviews with the doctors. One of them also gave ethical arguments for his stand on this question. According to him, age-based prioritization could be justified on the basis of a fairness argument:

> But we consider age, we do. In some respects I think that we – without expressing it to ourselves – regard this as a question of justice….that it is unfair to live for only 50 years. But when you are in your 80s, you have already had your due share, so to speak. (Doctor)

Apart from this, the empirical material also included examples of how priority setting could be affected not only by the patient's age, but also by factors such as gender and ethnicity:

> I cannot say that I think the older patients to a higher degree, sort of, cry out for authority. /--/ But a rather difficult group when it comes to authority are the immigrants…Like Persian immigrants. Particularly old, female ones… it's very hard to get them to take their own decisions. (Doctor)

Likewise one of the auxiliary nurses pointed out that age and gender sometimes cooperated:

> These old persons don't want to cause any trouble, especially not the women. (Auxiliary nurse)

The analysis of the interviews shows that the priorities were highly influenced by the patients' age, but also by factors such as gender and ethnicity. Concerning the age-based priorities, the informants were quite aware of them and they also gave ethical justifications for their actions. The prevalence of gender-based inequality, however, seemed to be much more implicit and unconscious for the informants, as was its connection to ethnicity. According to the informants, when priorities are to be set, women in general are not as eager to claim their rights as men are. This was emphasized even more in relation to ethnic and cultural traditions. The plausible consequence of this is that the ageism prevalent in health care hits women harder than men. Old, immigrant women seem to be those in greatest danger of being subjected to unjust priorities.

The results of this investigation point to the fact that there is a gap between theory and practice when it comes to health care ethics on the clinical level. To work against this and avoid injustices in priority setting, an increased ethical competence among health care providers is necessary. Health care personnel must be made

aware of how they set priorities and on what grounds they make their decisions. Such increased competence must include awareness of how age, gender and ethnicity can cooperate in a negative way, causing members of certain groups in society to suffer from unjust priorities. The fact that the informants in the study were unaware of the sexism, but not the ageism and racism in health care points to the need for increased gender competence among health care personnel.

The Swedish policy for handling the ethical dilemma of prioritization in health care is clearly marked by the traditional bioethical assumptions discussed above, namely principlism and individualism. The presented investigation shows how aspects like gender, age and ethnicity are obscured by this approach. An ethic of principles assumes a generalized moral subject, instead of embodied, gendered persons. Further, the ethical platform, consisting of three ethical principles, was obviously assumed to apply equally to all patients, but the investigation shows that it does not. Certain patients were subjected to unjust priorities due to their group affiliation. In order to avoid injustices of this sort, greater context sensitivity as well as attention to groups is necessary within bioethics.

Conclusion

In this article, I have argued that the lack of gender perspectives in bioethics mainly depends upon two main features of the tradition, namely, the dominance of principles and the influence of liberal individualism. As the focus upon groups and their moral interests has not been explored to a great extent within traditional bioethics, injustices based on identity constituting factors, such as gender, ethnicity, age, class, and sexuality, have gone unobserved.

My presentation has reported on recent advances in bioethics in which gender has been developed, for example, through critique of principle-based ethics and the development of the ethical principle of autonomy. Finally, one example from my own research of bioethics with a gender perspective was presented, namely, a study on how gender, age and ethnicity influence priority setting in health care. This study also served as an example of how a gender perspective impacts the topic and method as well as the theoretical analysis in bioethics.

As Susan Dodds has pointed out, it can no longer be said that gender studies are on the periphery of bioethics (Dodds 2004:1). The work of bringing gender into the field of bioethics has been going on for more than a decade. The early work on feminist bioethics emphasized care and reproductive ethics. Today, gendered bioethics is not found only in the areas of sexual and reproductive health or in research on the role of women as patients, but rather it concerns nearly every topic of the current bioethics debate. It is also clear that it has shifted focus, from critical responses to constructive contributions. Still, much work remains to be done. Gender theory brings with it great opportunities and research challenges for bioethicists in the future.

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14. Janne Bromseth & Frida Darj (red.) (2010) *Normkritisk pedagogik – Makt, lärande och strategier för förändring* (290 pp.) 190 kr; 19 EUR

15. Blomqvist, Martha & Ehnsmyr, Ester (eds) (2010) *Never Mind the Gap! Gendering Science in Transgressive Encounters.* (238 pp.) 150 kr; 15 EUR

NEVER MIND THE GAP gives an informed and up-todate overview of a new generation of feminist science studies, encountering the nature/culture research field. It illuminates the great variety of approaches in studies conducted in the field, pointing at recent advances, present challenges and possibilities, and it provides ample references for anyone interested in further reading. This publication should therefore be of interest not only to researchers already involved in the research areas presented here, but to anyone who wishes to keep an eye on recent developments in these fields of research trying to transgress boundaries between nature and culture and to develop a better understanding of gender aspects in natural sciences. We hope that the book will challenge at least some of the readers' assumptions about 'other' disciplines as well as their own.

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