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GENDER EQUALITY IN ENGINEERING
THROUGH COMMUNICATION AND COMMITMENT
(GEECCO)

ENHANCED GENDER KNOWLEDGE AND NEW CONTENT

Citation:

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GEECCO – Gender Equality in Engineering through Communication and Commitment. In a Nutshell

Scientific and technological innovations are increasingly important in our knowledge-based economies. Today STEM (Science, Technology, Engineering, and Mathematics) is literally everywhere; it shapes our everyday experiences. With technologies we choose e.g. structures that influence over a very long time how people are going to work, communicate, travel, consume, and so forth. It is thus both a question of competitiveness and justice, to achieve gender equity within science and technology institutions, including policy and decision-making bodies.
GEECCO with its project lifetime from May 2017 to April 2021 aimed to establish tailor-made Gender Equality Plans (GEPs) in 4 European RPOs and to implement the gender dimension in 2 RFOs (funding schemes, programmes and review processes). All participating RPOs were located in the STEM (Science, Technology, Engineering, and Mathematics) field, where gender equality is still a serious problem and whose innovations are increasingly important in the knowledge-based economies.
GEECCO pursued the following objectives in order to enhance systemic institutional change towards gender equality in the STEM-field:

(i) Setting up change framework and a tailor-made GEP for each participating RPO;
(ii) Implementing gender criteria in the activities of RFOs;
(iii) Setting up a self-reflective learning environment in and between all RPOs und RFOs to participate from existing experiences and match them with their specific needs and circumstances.
(iv) Evaluate GEP implementation within the participating RPOs and RFOs with a quantitative evaluation using monitoring indicators and a qualitative monitoring to enhance and fine-tune implemented actions over the course of the project.

http://www.geecco-project.eu/

https://www.tuwien.at/tu-wien/organisation/zentrale-bereiche/genderkompetenz/gender-in-der-forschung/geecco-resultate

Further resources developed by the GEECCO-project consortium

All public deliverables, resources and additional material can be downloaded on this website:
https://www.tuwien.at/tu-wien/organisation/zentralebereiche/genderkompetenz/gender-in-der-forschung/geecco-resultate

Public deliverables (in order of the related work packages)

- Postorino, Maria Nadia; Marino, Concettina; Suraci, Federica; Enzenhofer, Bettina; Lusa, Amaia; Costa, Carme Martínez; PulawskaObiedowska, Sabina (2018): Gender Analysis of Decision-Making Processes and Bodies. GEECCO. Gender Equality in Engineering through Communication and Commitment (a H2020 project).
- Postorino, Maria Nadia; Marino, Concettina; Suraci, Federica; Enzenhofer, Bettina; Lusa, Amaia; Costa, Carme Martínez; PulawskaObiedowska, Sabina (2018): Overview on Improvements and Procedures. GEECCO. Gender Equality in Engineering through Communication and Commitment (a H2020 project).
- Bryniarska, Zofia; Żakowska, Lidia; Enzenhofer, Bettina; Postorino, Maria Nadia; Marino, Concettina; Lusa García, Amaia (2018): Current Status of Women Career Development. GEECCO. Gender Equality in Engineering through Communication and Commitment (a H2020 project).
- Enzenhofer, Bettina; Lusa García, Amaia; Sarnè, Giuseppe; Żakowska, Lidia (2020): Overview on How to Increase Female Visibility. GEECCO. Gender Equality in Engineering through Communication and Commitment (a H2020 project).
- Knoll, Bente; Renkin, Agnes (2018): Analysis of Current Data on Gender in Research and Teaching. GEECCO. Gender Equality in Engineering through Communication and Commitment (a H2020 project).
- Ratzer, Brigitte; Burtscher, Sabrina; Lehmann, Tobias; Mort, Harrie; Pillinger, Anna (2020): Enhanced Gender Knowledge and New Content. GEECCO. Gender Equality in Engineering through Communication and Commitment (a H2020 project).
- Ratzer, Brigitte; Enzenhofer, Bettina (2019): Integrating Gender Dimensions in the Content of Research and Innovation. An Exhibition. GEECCO. Gender Equality in Engineering through Communication and Commitment (a H2020 project).
- Lasinger, Donia; Nagl, Elisabeth; Dvořáčková, Jana; Kraus, Marcel (2019): Best Practice Examples of Gender Mainstreaming in Research Funding Organizations. GEECCO. Gender Equality in Engineering through Communication and Commitment (a H2020 project).

- Dvořáčková, Jana; Navrátilová, Jolana; Nagl, Elisabeth; Lasinger, Donia (2020): Guideline for Jury Members, Reviewers and Research Funding Organizations' Employees. GEECCO. Gender Equality in Engineering through Communication and Commitment (a H2020 project).
- Lasinger, Donia; Nagl, Elisabeth; Dvořáčková, Jana; Kraus, Marcel (2020): Overview and Assessment of Gender Criteria for Funding Programmes. GEECCO. Gender Equality in Engineering through Communication and Commitment (a H2020 project).
- Kraus, Marcel; Dvořáčková, Jana; Lasinger, Donia (2021): List of Principles of Communication of Gender Criteria. GEECCO. Gender Equality in Engineering through Communication and Commitment (a H2020 project).
- Mergaert, Lut; Allori, Agostina; Ratzer, Brigitte; Enzenhofer, Bettina; Lusa García, Amaia; Marino, Concettina; Zakowska, Lidia; Bryniarska, Zofia (2020): Tailor-made Gender Equality Plans (GEP version 3.0). GEECCO. Gender Equality in Engineering through Communication and Commitment (a H2020 project).
- Knoll, Bente (2021): Dos and Don'ts while Degendering the STEM Field. Learning Experiences of Four European Universities and Two European Research Funding Organisations. GEECCO. Gender Equality in Engineering through Communication and Commitment (a H2020 project).
- Mergaert, Lut; Knoll, Bente; Renkin, Agnes (2021): Final Report on Supporting Activities. GEECCO. Gender Equality in Engineering through Communication and Commitment (a H2020 project).
- Jorge, Irene (2021): Implementation of Dissemination Activities. GEECCO. Gender Equality in Engineering through Communication and Commitment (a H2020 project).
- Jorge, Irene (2021): Engagement Activities. GEECCO. Gender Equality in Engineering through Communication and Commitment (a H2020 project).
- Lipinsky, Anke; Schredl, Claudia: Final Evaluation Report. GEECCO. Gender Equality in Engineering through Communication and Commitment (a H2020 project).

Additional resources and literature reviews

- Knoll, Bente; Renkin, Agnes; Mergaert, Lut (2020): Additional resources (living document). GEECCO. Gender Equality in Engineering through Communication and Commitment (a H2020 project).
- Burtscher, Sabrina (2019): Literature Review: Gender Research in Human Computer Interaction. GEECCO. Gender Equality in Engineering through Communication and Commitment (a H2020 project).

- Pillinger, Anna (2019): Literature Review: Gender and Robotics. GEECCO. Gender Equality in Engineering through Communication and Commitment (a H2020 project).
- Mort, Harrie (2019): A Review of Energy and Gender Research in the Global North. GEECCO. Gender Equality in Engineering through Communication and Commitment (a H2020 project).
- Lehmann, Tobias (2020): Literature Review: Gender and Mobility. GEECCO. Gender Equality in Engineering through Communication and Commitment (a H2020 project).

Explanatory videos (available on Youtube)

- Ratzer, Brigitte; Enzenhofer, Bettina (2019): Humans & Computers. Video produced under GEECCO. Gender Equality in Engineering through Communication and Commitment (a H2020 project). Available online at https://www.youtube.com/watch?v=vrWx91RdmGo, checked on 4/30/2021.
- Ratzer, Brigitte; Enzenhofer, Bettina (2019): Robots in our society. Video produced under GEECCO. Gender Equality in Engineering through Communication and Commitment (a H2020 project). Available online at https://www.youtube.com/watch?v=bfXr29VAuwU, checked on 4/30/2021.
- Ratzer, Brigitte; Enzenhofer, Bettina (2020): Energy for all. Video produced under GEECCO. Gender Equality in Engineering through Communication and Commitment (a H2020 project). Available online at https://www.youtube.com/watch?v=tIwrgsNVfW8, checked on 4/30/2021.
- Ratzer, Brigitte; Enzenhofer, Bettina (2021): Mobility for all. Video produced under GEECCO. Gender Equality in Engineering through Communication and Commitment (a H2020 project). Available online at https://www.youtube.com/watch?v=oMIfoI5-14M, checked on 4/30/2021.
- Ratzer, Brigitte; Enzenhofer, Bettina (2021): Inclusive design – why intersectionality matters. Video produced under GEECCO. Gender Equality in Engineering through Communication and Commitment (a H2020 project). Available online at https://www.youtube.com/watch?v=U4eRb1NM21A, checked on 4/30/2021.

Evaluation and monitoring tutorials

Anke Lipinski and Claudia Schredl, both from GESIS, developed five online evaluation and monitoring tutorials.

1. GEECCO Data Monitoring Tool
2. GEECCO Infographic: Gender Equality Approaches and Their Impact on GEP Implementation
3. GEECCO Infographic: SMART Gender Equality Objectives
4. GEECCO Explainer Video: Gender Equality Plans in Technical Universities and the Use of Logic Models
5. GEECCO Log Journal

These tutorials can be downloaded on this website:
https://www.tuwien.at/tu-wien/organisation/zentrale-bereiche/genderkompetenz/gender-in-der-forschung/geecco-resultate

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Aim of the document

This document presents the four literature studies that were elaborated within the GEECCO project. As described in the project proposal, we aimed to provide an enhanced gender knowledge base for particular STEM research fields. Thus, the status and the most important results of feminist and gender literature on selected technology topics was summarized. In addition to these studies - and going beyond the project proposal - explanatory videos were produced which summarise the content of the reviews in a short and concise form.

The literature studies are aimed at researchers and research funding institutions. They intend to facilitate a rapid understanding of gender aspects in the selected fields of research. The explanatory videos should address a broader target audience and raise awareness of the relevance of considering gender aspects in STEM research.

Literature reviews

According to the project proposal four research areas were selected that are either represented at all four GEECCO partner-universities (*Mobility*) or of particular interest due to their impact on everyday life (*Energy, Human Computer Interaction, Robotics*). An extensive literature search in each of the selected areas was planned. Four junior researchers - three of them from the master's programme in Science and Technology Studies at the University of Vienna and one computer science student at the TU Wien - were hired to carry out the studies. For each subject area, experts were asked to provide specialist feedback.

Within the reviews it turned out that four distinct approaches were reasonable. In the field of *Energy*, the debates about/in the global South are predominant but dealing with completely different topics than the debates concerning the global North. Both strands of discussion are shortly described, however discussions in the Global North are worked out in detail.

The *Robotics* field is a very complex and heterogeneous research landscape where we identified a number of different applications as specifically gender relevant respectively gender literature is available there. This is namely the sector of care and robotics, household and robotics, sex robots, war robots and gendered robots in general. Discussions of both feminist/ gender aware roboticists as well as social scientists are lined out and the most important arguments and discourses are presented.

The field of *Human Computer Interaction* gave more than 2.000 hits with a quick literature search for gender or related terms. This led to a focus on meta-studies as well as the attempt to identify meaningful case studies. An important aspect there is “poor gender research”, so the literature review also deals with “how to avoid stereotyping or false positive results” in a separate section.

In the field of *Mobility*, there is also plenty of gender research available. Two major research approaches were found and elaborated: qualitative, more social scientist approaches and quantitative approaches from e.g. transportation science. A list containing a number of respective guidelines, toolboxes, and further resources on “gender, mobility and planning” to provide background knowledge and practical guidance is included in the review.

All reviews have been shared for feedback with experts in the respective fields and with the “Gendered Innovations 2” group and are available at the GEECCO project homepage.
http://www.geecco-project.eu/resources_results/geecco_material/
In accordance with the GEECCO project proposal the videos are also available on the portal http://www.geschlecht-und-innovation.at/

Explanatory videos

In the course of the completion of the literature studies, it became clear during discussions with experts who were invited to give feedback that the very compact and complex structure of the studies is a challenge for those who have no previous contact with gender issues. In addition to the literature reviews, TUW decided to produce explanatory videos. These videos shall support researchers as well as funding agencies in understanding the essential messages. They do however also address a broader target audience to raise awareness of the relevance of considering gender aspects in STEM research and innovation.

Two videos have been completed so far, these are the videos on *Robotics* and *Human Computer Interaction*. The other two videos on *Energy* and *Mobility* are currently produced and will be available by the end of 2020. All videos have been produced both in German and English language.

Videos are available at the GEECCO homepage (http://www.geecco-project.eu/resources_results/geecco_material/) as well as on youtube, so far the following videos can be found there:

Menschen & Computer https://youtu.be/Y6PNYgGlbcU

Humans & Computers https://youtu.be/vrWx91RdmGo

Roboter in unserer Gesellschaft https://youtu.be/s709M6dGwz0

Robots in our society https://youtu.be/bfXr29VAuwU

Results and first dissemination steps

Type of Deliverable: Website

The new content on the portal http://www.geschlecht-und-innovation.at/ has been added to the existing case studies on gender in STEM field. See http://www.geschlecht-und-innovation.at/fallstudien/

As the literature studies and videos are to be made known to as wide a circle of people as possible, special attention is now paid to dissemination of the results of the project. Currently the literature studies are available on the "Geschlecht und Innovation" portal and on the project homepage of GEECCO (http://www.geecco-project.eu/resources_results/geecco_material/).

The reviews on energy and human computer interaction additionally were sent out via the "Gendered Innovations" mailing list of Londa Schiebinger.

The content of the literature studies has also been presented at various workshops and conferences with different target groups:

Trainning sessions	TUW	Gender in Research: Brigitte Ratzer Presentation of Reviews	23/10/2019 Vienna national	Gender working group of all Austrian RFOs
Trainning sessions	TUW	Gender in Research: Brigitte Ratzer Presentation of Reviews	12/12/2019 Vienna national	Presenting 4 reviews on gender in research to TUW stakeholders (research support, ethics, HR department ...)
Trainning sessions	TUW	Gender in Research: Brigitte Ratzer Presentation of Reviews	24/01/2020 Vienna national	Presenting 4 reviews on gender in research to TUW Committee on Equal Treatment
Bologna european		Final Conference Brigitte Ratzer of PLOTINA	Designing Robots – Changing Gender project Conferences TUW 28/01/2020	Presenting results of WP 6, title of talk: Stereotypes, Challenging Norms
Trainning sessions	TUW	Gender in Research: Brigitte Ratzer Presentation of Reviews	25/02/2020 Vienna national	Presenting 2 selected reviews on gender in research to WWTF staff

Feedback was always excellent, so we consider that the literature studies fulfil the intention of providing researchers and RFOs with both initial orientation and further information.

Annexes:

- Sabrina Burtscher: Literature Review: Gender Research in Human Computer Interaction
- Tobias Lehmann: Literature Review: Gender and Mobility
- Harrie Mort: A Review of Energy and Gender Research in the Global North • Anna Pillinger: Literature Review: Gender and Robotics

Review

Literature Review: Gender Research in Human Computer Interaction

Sabrina Burtscher

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Contents

Introduction

The present report is the outcome of a literature research conducted as a part of the Horizon2020 project “Gender Equality in Engineering through Communication and Commitment” (GEECCO, grant agreement No 741128) on gender in Human Computer Interaction (HCI) research. The purpose of this document is to

- provide readers with a basic understanding of gender, and HCI
- present an overview of how gender research in various HCI contexts has been conducted and documented,
- and provide recommendations for making HCI research gender aware, and more inclusive.

“Gender” appears to be a characteristic that researchers tend to rely on for finding significant differences in their data, although this often occurs as a pure add-on to their actual research (Hines 2004; Maccoby and Jacklin 1974; in Fine et al. 2019). The widespread use of “gender” is illustrated, for example, by the two thousand-odd entries under the keyword “gender” in the ACM digital library (March 12, 2019). Since it would be very difficult to sift through and review them all, I decided to find a meta-analysis on gender and intersectional HCI, and review examples drawn from that report. A fairly recent meta analysis with a soundly sampled corpus resulted in the 2017 paper “Intersectional HCI: Engaging Identity through Gender, Race, and Class” by Ari Schlesinger, W. Keith Edwards, and Rebecca E. Grinter.

For their report, Schlesinger, Edwards, and Grinter examined 140 papers presented at CHI, the ACM Special Interest Group on Computer-Human Interaction’s conference and mapped how “the user” is constructed in those papers. They concluded that “gender research” often still means “research concerning women” or “research about women”, while issues concerning men are posited as “neutral”, applying to everyone, and genders outside the binary construction are rarely present.

The possible effects of gender roles and stereotypes on projects varies greatly, which means that there is no “one size fits all” approach to making projects gender-inclusive. This can be seen in projects spanning various fields, ranging from architecture to industrial design (Bardzell 2010). The goal of the present paper is to offer recommendations to both researchers and funding organizations on where to look for gender issues, and how to discuss and handle them.

I selected seven papers from the 140-paper corpus that Schlesinger, Edwards, and Grinter discuss, in order to cover a wide range of topics and research fields, as well as various intersections of gender(ed) issues. As a whole, the papers show different ways of studying, constructing, and considering gender in research. I discuss possible pitfalls when trying to take gender into consideration (see Breslin and Wadhwa 2017), and show in the following sections where researchers have avoided them, and how. Additionally, some examples from industry illustrate impacts that occur when gender research is missing or has gone wrong.

Initially, I looked for ways to meaningfully engage with gender as a variable in HCI research. Looking at the selected case studies included in Schlesinger, Edwards, and Grinter (2017), however, my focus broadened to also include the structure and context of the research projects. Drawing from this, I provide recommendations on how research can be done considering the concept of intersectionality, because as we will see, gender is not the one and only influence on adoption and usage of technology.

Definitions: Gender

In order to talk about how gender research is done, and how it could or should be done, it is important to discuss what "gender" means, and to introduce a few important terms.

Breslin and Wadhwa 2017 (p. 74) present the following distinction:
"Sex: A person's biological classification as male or female, including physical appearance, chromosomes, hormones, reproductive organs, and secondary sex characteristics.
Gender: A person's self-identification and expression in relation to what is considered socially masculine, feminine, or other gendered category, within a given context."

Note that the terms "male" and "female" apply to the biological classification, while when talking about gender, "masculine" and "feminine" are used.

Sex differences are biological differences, for example, concerning uteri or penises, prostrates, fat distribution, or bone density. When researching sex differences, it is important to make explicit which differences are being researched, instead of using the blanket terms "male" and "female". That way, readers have a better understanding of what was included in the research/design, and outliers (for example male research participants with "atypical" body fat distribution) can be better explained.
In HCI/Computer Science, these bodily differences can impact, for example, work on fitness tracking apps, health tracking apps, voice activation, etc. The question is which bodies the hardware works for, and if the software really has the ability to capture what is important? Real-life examples are smartphones that are too big for small hands, standard office temperatures in smart buildings based on the more active metabolism of male office workers, and voice recognition software for interactive children's toys that does not recognize higher pitched voices. The underlying issues in these examples are different body sizes, variations in metabolism, and differences in voice pitch. The physical differences of users and study participants are not an issue – failing to account for them, on the other hand, is a serious oversight.

In contrast, gender differences are based on social and cultural factors affecting the ways in which people handle things. For example, social norms code certain tasks as "women's work", which impacts the number of men completing them, as well as the tasks'1 overall image and importance. Looking at gender differences means scrutinizing assumptions about things, and their image, and how assumptions and image impact the choice people do (not) have. Often, gender differences can be found even in things assumed to be neutral, for example, in a town's snowplowing pattern. One town in Sweden changed their snowplowing pattern, turning from "main roads first, then sidewalks and smaller roads" to the exact opposite. The city council found that the original pattern had been planned with

traffic behavior in mind that primarily represented men, who mostly use main roads to commute to and from work, while women "daisy-chain" various tasks, relying more on side-roads, and walking more. With the new system, walking accidents due to snow on sidewalks decreased significantly. Thus, the system change had positive impacts on women's everyday ways (and lives) as well as on the city's health costs, as the number of hospitalizations due to these accidents decreased, too ("Invisible Women" 2019).
In HCI/Computer Science, renowned work on gender differences includes, for example, Sherry Turkle's "Computational Reticence" (1986), and Fisher and Margolis' "Unlocking the Clubhouse" (2002). Both study

gender issues, the former as related to the choice of field of study and hobbies, and the latter, continuance in CS careers. They look at what image women and men have of computers, in general, or of CS studies, where these images come from, and how they impact who enters a field, and who stays. Other works focus on how software can implement different features to become more usable for women, for example, to help them steer clear of harassment on social networks.

Thus far, we have talked about sex and gender in a very binary way, with male/masculine on one side, and female/feminine on the other. However, both biology and gender studies, have now accepted that gender is not binary. This is also recognized in various countries and cultures, and their respective legal systems – some have recently adapted, some have already long been aware (Breslin and Wadhwa 2017). Germany's "dritte Option" ("third option"), is not a legal third gender, but rather, an "other" entry, for people who do not fit into the hitherto binary options for various reasons. Austria's third option, on the other hand, is at the time of writing, explicitly limited to intersex people who are born with physical characteristics (anatomy, hormonal constellation, reproductive organs) that do not fit the constructed norms of male and female (UNFE 2015; van Lisdonk 2014; Ghattas 2019). As gender is assigned to people at birth based on their physical characteristics, it is possible that the assignment does not match their actual gender. The term trans or transgender describes a person whose gender does not match the one they were assigned at birth. In contrast, a person whose gender fits the one they were assigned at birth is called "cisgender" or "cis" for short. Finally, a person whose gender identity is neither masculine or feminine is described as non-binary.

However, people can hardly be described by only one characteristic. This is where the notion/methodology of intersectionality comes in: different socio-demographic factors interact with each other, forming an identity, and at the same time constructing how people are seen, perceived, and treated, and which resources they have access to (Haraway 1988; Harding 2015). Taking this congregation of attribution by oneself and others into account, it is obvious that these factors cannot be analyzed separately. As Schlesinger, Edwards and Grinter put it: the impact of identity on context and design in HCI must be a focus of intersectional analysis. For example, a white cis woman will have different experiences at her work place than a Black2 cis woman, but also different than a White trans woman or a First Nations non-binary person.

Research: Pitfalls

As stated above, gender affects what we do, and how we do it – including the interactions we have with other people, the research we do, and the designs we create, and for whom. Breslin and Wadhwa (2017) talk about some pitfalls that come with the (gender) norms incorporated in our societies and technologies.

In the following, these pitfalls will be introduced and illustrated with examples of product design issues, such as speech recognition and image tagging software, but also more tangible, non-computer- related things such as protective gear. The explanation of these pitfalls tends to use examples with only binary genders. This is mostly due to the fact that if gender is considered, this mostly happens in a binary way (as seen for example in Schlesinger, Edwards, and Grinter 2017).

More detailed examples from areas of business and industry can be found starting on page 32.

I-methodology: “Everyone is like me”

Designers and developers often use themselves, or their immediate surroundings, as models for the things they create (Breslin and Wadhwa 2017, p. 72), and derive ideas for products from their own experience. A common adjacent is the hallway testing method, where designers/developers ask people walking down a hallway to test a design/product.

While these methods are not per se negative, they introduce a certain bias into the pools of ideas and test subjects. According to data quoted in Breslin and Wadhwa (2017, p. 72), 80–90 percent of position holders in tech are men, and 92–94 percent are Whites and Asians at, for example, Google, Facebook and Twitter. This bias is not an issue specific to Silicon Valley or the USA, but rather to the field of computer sciences in general: At TU Wien, my alma mater and Austria’s largest technical university, the numbers are similar: about 85 percent of the students in computer science are men3 who are likely to share a certain set of experiences such as having studied at a HTL4 (Grabher, Unger, and Zaussinger 2014).

These sets of experiences lead to the development of products that perfectly cover the represented majority group’s needs, but completely exclude others’ requirements and desires. For example, many health trackers in their first (publicly available) iterations could not recognize the workout/activity of someone pushing a baby stroller.5 Similar bias in training data sets can impact the basic functionality of software even making it completely dysfunctional (DeVries et al. 2019). While men’s voices can operate voice-controlled software without any issue, women have been reported struggling to do so in various settings (Criado-Perez 2019; Tatman 2016). Drawing from their own needs, experiences, and requirements, many ideas and products developed by the well-situated white men in IT focus on and serve privileged lives. Ride-share services, food delivery and cooking services, laundry services with pick-up and delivery – many recently very successful companies of the share economy can be dubbed “technologies replacing [the developers’] mums.”[6]

One Size Fits All: “Everyone is the same”

The issues of “one size fits all” and “works for me” thinking derive from the above-mentioned situation that the work forces in IT and HCI are very homogeneous.

The issues stemming from this methodology can be seen in both hardware and software. When hardware is modeled with only some users in mind, phones, game controllers, and sensors might not work for the actual users. When people are meant to interact with something, it should fit – but often, products are too big for women’s bodies. Smartphones and game controllers that are hard to grasp hold of, and heartrate chest-straps that cannot be tightened enough to fit one’s chest, or cannot be worn in combination with a sports bra, are possible consequences. Worse than these inconveniences, studies show that protective gear, no matter the area of application, is modeled to accommodate men’s bodies – thereby leaving women unprotected, occasionally even hindering them (Criado-Perez 2019).

In software, for example, web search term suggestions, and machine learning/artificial intelligence (AI) can also be seen as an application of the “one size fits all” approach. Here, large amounts of data are used to draw conclusions of what is “important” or “correct” for users. However, “big data” also has its biases – and can thus result in strange “majority votes”. For example, when Microsoft presented their AI “Tay” to twitter, users taught it how to be racist and sexist within mere hours. The auto-complete

feature embedded in Google's search function shows a similar bias towards sexist and racist stereotypes, asking, for example, if women are "attracted to money" (Criado-Perez 2019).

Gender Stereotyping: "All women are alike"

The pitfalls mentioned above are cases of implicit gendering, where people just did not think that gender has impacts on their work. Gender stereotyping, however, is a sign of explicit gendering – here, people did realize that there might be differences between women and men. However, reflection on why women buy and use certain things, in comparison with the products bought by men, did not necessarily take place. Making explicit the assumptions used and ways that decisions were made provides a way to improve design/research. However, explicit "design for women" can result in "shrink it and pink it" (SNP), or bad stereotyping. Literal SNP has been, for example, repeatedly applied totool kits. While it is correct that many standard tools like wrenches are too big for women's hands6, making them pink is an unnecessary instance of othering (Dervin 2015). Pinkification can also be seen in children's toys, for example, toy medical kits, or campaigns that aim to make the STEM field more interesting to girls by showing, for example, that chemistry has many applications in cosmetics.
Design approaches such as SNP cater to stereotypes and reproduce them rather than making technology more inclusive. They also make it hard for men to use the "pinkified" designs. Furthermore, they disregard the fact of inter-group diversity, such as the existence of tech-savvy women, and the many differences between women in relation to culture, sexuality, socioeconomic status and other categories of difference (Breslin and Wadhwa 2017, p. 73).

But not only are some products made "more feminine" in order to sell them to women: marketing and design also work the other way around, making products "more manly" in order to make "unmanly" products more appealing to men. Examples of this include, but are not limited to, chocolate,7 and hot sauce.8 Hot sauce in Central Europe and the US often has a masculine connotation, with labels depicting symbols of death and destruction (using skulls, fire, and the like) while in Latin America, labels tend to depict motherly figures, as cooking and seasonings have a female connotation, and hot sauces are nothing other than a seasoning. Similarly, preparing meat outdoors has been reframed as a "manly BBQ".9

One famous, and often-used example of gender stereotyping in HCI/computer science is the prompt to "explain something so your grandmother can understand it", which is often used in job interviews, or oral exams, to see if someone really understands a concept. This completely ignores the option that the testee's grandmother might be an avid user of the concept in question.10

To avoid stereotyping, many institutions use personas, which are abstract representations of users. Using personas is meant to help developers/researchers identify and understand their target audience (Pruitt and Grudin 2003). Personas may include demographic information, goals, and scenarios involving the topic of research, for example, what a user might want to accomplish using a software. They can shed light on different needs and requirements of different user groups, when applied properly. For example, good personas would show that the usage of a washing machine differs strongly depending on household size, or if the washing machine is placed in a student dorm. However, creating good personas requires time, information, and insight. When inadequate time is put into creating the personas, one runs the risk of relying too heavily on stereotypes, thus introducing into the project what one had tried to avoid in the first place.

Gender difference: “Women are inherently different”

There are some things where men and women are different; some things, where male and female users are different; and some things where people are different. Gender is just one parameter in the big picture – but these differences should not be seen as natural or inherent. Instead, as stated above, sociocultural context plays an important role – gender roles vary, depending on when and where one looks (Ceci et al., 2009 in Breslin and Wadhwa 2017, p. 73). For example, while pink is rather strictly assigned to girls and blue to boys nowadays, these assignments were less strict until the first half of the twentieth century (Stimpson 1930; Paoletti 1987).

Prevalent issues when looking at gender difference are: binary division, mashing up sex and gender, and immutability of gender (Keyes 2018; Schlesinger, Edwards, and Grinter 2017; Breslin and Wadhwa 2017). Binary division has been discussed in the chapter “Definitions: Gender” (page 4). Mashing up sex and gender is easily explained: you say “gender”, but look at physical things, like body fat distribution (see chapter “One Size Fits All: “Everyone is the same”, page 9). Immutability of gender describes the assumption that gender is something fixed – once assigned, this assignment cannot be changed. This disregards the fact that the same person may sometimes challenge gender norms, and sometimes adhere to them, depending on context, place, or time. For example, a person may very well feel content within their assigned role for a time, but later in life want to break it. This can also be temporary or depending on a situation – a hacker who likes to create robots may sometimes just want to bake cookies. The former does not make her less of a woman, the latter does not make her less of a hacker.

Case Studies

In this section, discussing the case studies from Schlesinger, Edwards, and Grinter (2017), as well as a few examples from the industry, we will see different kinds of gender research. Some will be applications of the pitfalls that have been described in the previous section, while others show how to successfully avoid them.

Schlesinger, Edwards, and Grinter (2017) conducted a meta-review analyzing how users are identified or classified in HCI research. To that end, they collected 140 papers published between 1982–2016 by CHI11 on gender, ethnicity, race, class, and sexuality. Findings include that identity-focused research tends to analyze one dimension of identity at a time (for example, gender OR race, but not both). In addition, the authors found that research on gender and socio-economic class is more common than on ethnicity and race. The paper contains helpful recommendations on including intersectionality in HCI research, such as clear reporting of context and demographic information, inclusion of author disclosures, and deeper engagement with identity complexities.

Each of the following case studies will be analyzed as follows: I start with a short description of the research and, when applicable, the associated project(s) and their connection to HCI, followed by gender aspects included in the research. Each analysis ends with answers to the question: “What can we learn from this?” A summary of the lessons one can learn from the discussed papers, together with specific recommendations targeted at researchers and research funding organizations is presented in the section “Discussion and Recommendations” on page 34.

The papers were selected in order to cover the wide range of topics included in HCI (see table below). Not all authors have made explicit where their research took place. Still, a strong bias towards works from the US (4) and the UK and Europe (3) is visible. One case study is rooted in Asia (ground work has been done there, some authors have US affiliations).

While I initially looked for ways to meaningfully engage with gender as a variable in HCI research, my focus broadened to also include the structure and context of the research projects while engaging with their presentations.

Case Study/Reference	**HCI connection** **ACM Classification Keywords**	**Gender Aspects**
1: Blackwell et al. 2016	studies how LGBT parents use social media H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.	gender as important part of LGBT parents' identity
2: Karuei et al. 2011	studies tactile interfaces H.5.2. User Interfaces: Haptic I/O — Tactile & Haptic UIs, User Interface Design, Handheld Devices and Mobile Computing, Multi-modal Interfaces	gender as independent variable
3: Otterbacher 2015	studies how bias may be introduced into data sets created with gamification systems I.2.6. [Learning]: Knowledge acquisition. H.5.2. [User Interfaces]: Natural language.	gendered differences in labels assigned to images
4: Clarke et al. 2013	studies how digital media can be used to help survivors of abusive relationships H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.	target group: women who left abusive relationships
5: Ahmed et al. 2014	user-centered design and creation platforms to share experiences of sexualized violence H.1.2. Human Factors	target group: women who have experienced sexualized violence

6: Haimson, Brubaker, and Hayes 2014	studies use of language in online personal ads H.4.3 Communication Applications; J.3 Life and Medical Sciences: Health; K.4.1 [Computers and Society]: Public Policy Issues: Computer-related health issues.	target group: men who have sex with men
7: James DiSalvo et al. 2011	created a system to introduce young African American men to computing as a profession H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.	target group: men who dis-identify with computing as a profession

Table 1: Overview of discussed Case Studies, HCI connection and Gender Aspects

Content Notes for Case Studies

I tried not to include potentially trauma-triggering content in this work. However, some of the cited works deal with trauma-related topics. In order for all readers to be able to make an informed decision on whether they can/want to deal with the respective contents when looking into the case studies, I provide the following content notes:

Case Studies 4 (Clarke et al. 2013) and 5 (Ahmed et al. 2014) deal with issues of gendered violence, specifically domestic violence and sexualized harassment in public spaces. Especially the article by Ahmed et al., however, contains quotes from people describing harassment against women.
Case Study 6 (Haimson, Brubaker, and Hayes 2014) deals with sexual health related language, focusing on men who have sex with men. It also touches on the topics of sexually transmitted infections and the HIV/AIDS epidemic of the 1980s.

Case Study 1: Blackwell et al. 2016

Blackwell, Lindsay, Jean Hardy, Tawfiq Ammari, Tiffany Veinot, Cliff Lampe, and Sarita Schoenebeck. 2016. "LGBT Parents and Social Media: Advocacy, Privacy, and Disclosure During Shifting Social Movements." In Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems, 610–622. CHI '16. New York, NY, USA: ACM. https://doi.org/10.1145/2858036.2858342.

For this paper, Lindsay Blackwell, Jean Hardy, Tawfiq Ammari, Tiffany Veinot, Cliff Lampe, and Sarita Schoenebeck12 looked at how LGBT parents use social media. LGBT parents here refers to people who are parents and identify as LGBT. Human-Computer Interaction here is the usage of social media: what kinds of social media are used? What do participants share, with whom, and how (for example use of friend group features to restrict information dissemination to people who are considered safe). The term "gender" is not contained in the papers' keywords, but gender is an important aspect of the research.
They group their findings into three primary themes (p. 614):

1. *"Detecting disapproval and identifying allies: LGBT parents use social media sites to obtain social cues that allow them to evaluate their safety in relation to others."* Contacts' reactions to, for example, news relating to marriage equality can be used by LGBT parents to determine whether it is safe to be open about their own identity with the respective contacts.

2. *"Incidental advocacy: LGBT parents become incidental advocates when posting online about their daily lives is perceived to be advocacy work." S*ome participants feel that their mere existence and visibility are acts of advocacy and resistance in times of anti-LGBT politics (in the US). Each and every posting on social media can become the starting point for discussions on equal rights for LGBT people.

3. *"Networked privacy management: for LGBT parents, online privacy is a complex and collective responsibility shared with children, partners, former partners and families."* Posting about oneself often includes information about others. This means that the posting person has the responsibility of assessing whether it is safe and okay for other people to be included in these postings. For example, there may be unwanted consequences for a teenager if their classmates found out that the teenager's parents are LGBT.

What can we learn from this?

Blackwell et al. give detailed information about who their study participants are, presenting data on their age, gender identity, sexual orientation, children's age(s), and region (Blackwell et al. 2016, p. 613). Blackwell et al. suggest that some of the work may also be applied to LGBT persons who are not parents, but that most is specifically about LGBT parents. Also, they do not blanket LGBT people, and for example, point out differences of same sex versus bisexual couples, and the effects a transition has on trans people and their friends and families. This way, Blackwell et al. can show the exact kind of influence a certain part of their participants' identities have on their social media usage. Rather than giving very general and crude information on "non-hetero parents", the readers are presented with meaningful insights into LGBT parents' lives and/on social media.

Blackwell et al. pay special attention to the vocabulary used throughout the paper. Talking about gender identity, sexual orientation, cis/trans, "chosen names" vs. "legal names", they explain what special terms mean. By explaining the term cis rather than trans, they avoid presenting cis as the norm. Furthermore, they

make explicit that during interviews, interviewers paid attention to the language used by each individual participant regarding their identity, so that the interviewer could adapt their own language for the rest of the interview. So, rather than using pre-found vocabulary and categories, participants' self descriptions and preferred expressions were used (p. 614).

One significant quote from a participant explains what intersectionality means: "Both are intrinsic parts of who I am. I'm always a parent and I'm always queer. The way I experience the world is based on and influenced by being queer, and by being a parent. I can't separate those things." (p. 615). In addition to sexual orientation and gender identity, the authors also present location (rural vs. urban), and socioeconomic status as dimensions of intersectionality (for example, it can be easier to be out and proud in big cities as opposed to rural areas), thus further enriching their descriptions.

Case Study 2: Karuei et al. 2011

Karuei, Idin, Karon E. MacLean, Zoltan Foley-Fisher, Russell MacKenzie, Sebastian Koch, and Mohamed El-Zohairy. 2011. "Detecting Vibrations Across the Body in Mobile Contexts." In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, 3267–3276. CHI '11. New York, NY, USA: ACM. https://doi.org/10.1145/1978942.1979426.

Idin Karuei, Karon E. MacLean, Zoltan Foley-Fisher, Russell MacKenzie, Sebastian Koch, and Mohamed El-Zohairy examine which body locations are more sensitive to vibrations and which are more affected by movement, whether/how visual workload, expectation of location, or gender impact the performance of tactile displays and whether users have subjective preferences to any of these conditions. The HCI connection is the usage of vibration emitters placed on the body to receive notifications when the user is not using/holding their device or if it is not stowed close to the body. In their findings, Karuei et al. report that gender has an influence on the detection rate of signals and response time, but also that this influence is neither consistent nor significant.

What can we learn from this?

In their experiments, the team balanced gender (male/female) "to allow the consideration of its impact, which could arise through, for example, gender-linked differences in body fat composition" (p. 3270). Thus, the research team manages to avoid the "One Size Fits All" pitfall, by actively including women in their research. Body fat composition (or distribution) however, is not related to gender, but to sex. This is inaccurate language. In addition, the implied hypothesis that body fat composition may have an impact on detection of signals is not properly tested, as Karuei et al. did not measure their participants' body fat. This is an example of gender stereotyping.

Also, the experiment falls victim to the pitfall of gender difference, literally positing "male"[13] as the norm: "Feet are the baseline for sites, *male for gender*, sitting for movement, no workload for workload, and first trial for trial number." (p. 3271). The normative aspect of language is very important in gender research and should be considered (compare, for example, to Blackwell et al.).

Overall, Karuei et al. did try to make their research gender aware, but stopped just shy of touching on truly fundamental gendered issues. This is especially visible when they discuss that "thigh was among the least effective and least preferred stimulus site we tested; and yet, front pocket is a common location to stow a mobile device, particularly for men" (p. 3275). The gendered issue here, of course, is clothing

itself, and how pants (and dresses, and skirts) designed for women often do not have pockets big enough for smartphones, if they have any at all.

In order to reorient this specific research more towards gender issues, the impact of (often gendered) clothing and (possibly gendered) differences in acceptance of emitters in certain body locations would be interesting points for discussion. In addition to this and the actual impact of fat distribution, for example, *more emitter locations* and *intensity of signals* could have been studied.

Especially with locations such as collarbone, stomach, and thigh, there may be many more reasons for poor user response than those mentioned in the hypotheses, for example, dense androgenic hair.

Case Study 3: Otterbacher 2015

Otterbacher, Jahna. 2015. “Crowdsourcing Stereotypes: Linguistic Bias in Metadata Generated via GWAP.” In Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems, 1955–1964. CHI ’15. New York, NY, USA: ACM. https://doi.org/10.1145/2702123.2702151.

Jahna Otterbacher looked into the results of ESP, a Game With A Purpose (GWAP), which was used to crowd-source textual data about images. In ESP, users are (randomly) paired up and challenged to agree on as many words (labels) to describe an image as possible within two and a half minutes. For every word the players agree on, they earn points, and a bonus when they were successful with fifteen images. In order to create specific labels instead of very general ones, the game shows a list of taboo words. Taboo words are selected based on the frequency of their use to describe an image (also by other players). So, for example, two players may be shown an image of a table laid out for dinner. In the beginning they will earn points for labeling it “table”, and “dishes”, but when enough players have used these terms, labels will have to become more specific, for example “Hanukkah” if matching decoration can be seen on the image.

This work connects to HCI as it deals with the use of gamification to improve natural language processing. It studies how bias may be introduced into data sets used to train machine learning algorithms, which in turn can cause biases in automated decisions. Otterbacher states that there is already a noteworthy body of research on how tasks can be gamified, and on the incentives the games provide to the players (p. 1956). Gender is the focus of the research, with the goal being to find if and how gender stereotypes enter into the labels generated for images via ESP.

To do so, Otterbacher compares characteristics of labels for 18,916 images of men and 14,628 images of women, looking at (original emphasis, p. 1958f.):

- The proportion of assigned labels that are *adjectives*.
- The proportion of adjective labels that are *strongly subjective*.[14]
- The proportion of subjective adjective labels that have *positive/negative prior polarity*.
- The most frequent strongly subjective adjectives.

Otterbacher’s results provide evidence that players tend to describe *how* they perceive the women to be (labeling them with adjectives) while describing *what* the men are (using nouns, for example occupations). Looking at the strongly subjective adjectives most frequently used to describe either men or women, Otterbacher finds that all reference either “physical appearance (for example, sexy, ugly,

cute) or disposition or character (for example, angry, happy, fun)" (p. 1960). In detail, they found impressive gender differences: of the top ten subjective adjectives used to describe men, only two specify their appearance. In contrast, of the top ten subjective adjectives used to describe women, five describe their appearance. Overall, 2,425 images of women (16.6 percent) were labeled using the most frequent, subjective label of "sexy". The same label was used to describe only 20 pictures (0.1 percent) of men.

Another part of the analysis considers the differences in labels for images labeled as homosexual. Otterbacher reports a higher probability for adjectives if the players believed the depicted person was homosexual. Accepting that stereotypical language and beliefs are at the same time descriptive (how something is) and prescriptive (how something is supposed to be), the analysis of the labels suggests similar expectations of heterosexual women and gay men (p. 1961).

Otterbacher also includes some thoughts about the images included in the game and the analysis. Considering that they were collected from online resources and selected randomly, they probably represent a wide variety of depictions of people. However, it is also important to remember there are remarkable differences in the images of men and women shared on the Web – for example, there might be more pictures of physically attractive rather than "normal" women available, while for men this ratio might be even greater. In order to find out if the gender biases discovered in their first analysis hold true for less biased sets of images, Otterbacher designed also analyzed images in contexts where labels had been assigned related to occupations (p. 1961). One example resulting from this in-depth analysis is that players have distinct biases against women doctors: half of the images of women doctors are labeled "nurse", while the same label never occurs with depictions of men. This indicates thestereotype that women are mostly likely nurses, while men are doctors (p. 1962).

What can we learn from this?

The first thing, and most easy to do, concerns the pronouns Otterbacher uses when talking about people of unknown gender: Otterbacher uses "she/her" pronouns, for example on page 1957 (my emphasis): "The more expectancy-incongruent a person and *her* behavior appears to us, the more likely we are to describe the person with more concrete language […]".

Otterbacher discusses the fact that there are more than two genders, and more sexual orientations than hetero- and homosexuality, and reasons why both features can only be studied in simplified terms: "[W]e identified the subset of images with one or more of the following labels: gay, homosexual, lesbian. This resulted in four sets of images, based on ESP players' perceptions of the subjects' genders and sexual orientations […] We were not able to explore the labels used to describe images of people of additional genders / sexual orientations as they did not appear with adequate frequencies in the dataset" (p. 1959).

Finally, Otterbacher explicitly considers where the data for their research comes from, and what kind(s) of bias(es) it may contain, and designs a second analysis to test the results of the first. When testing results for women against results for men, and finding differences, looking at subgroups can provide further insight. In this specific example, expectations towards women seen as heterosexual and men seen as gay, were found to bear similarities. For other research, these subgroups could be related to age, location, or education.

Case Study 4: Clarke et al. 2013

Clarke, Rachel, Peter Wright, Madeline Balaam, and John McCarthy. 2013. “Digital Portraits: Photo-Sharing After Domestic Violence.” In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, 2517–2526. CHI ’13. New York, NY, USA: ACM. https://doi.org/10.1145/2470654.2481348.

Rachel Clarke, Peter Wright, Madeline Balaam, and John McCarthy worked with six women who had left their abusive partners in the last one to six years. The goal of their research was to explore how existing photography technology could be used to help women after a life disruption, such as leaving an abusive relationship. Most often in this area, HCI research considers communication technologies, and how they can be used by abuse survivors to maintain their social life, while at the same time evade their abuser(s). The project described in the paper I discuss here can be seen as a variation in which assistive technology is developed – here, the technologies themselves already exist, and their application and impact on the users’ lives come under scrutiny.

The project focused on the use of photo-sharing, “as a particular kind of digital media sharing that supports face-to-face social interaction across a number of flexible formats; tangibly through prints, digitally on screens and storied through creating video sequences” (p. 2518). Photo-sharing (as presentations, in digital/analog albums, as prints, etc.) as well as photography itself incorporate acts of storytelling (by choosing what to show, and how), which in turn helps construct identity and build relationships.

Often in HCI projects, focus is on researching existing designs and artifacts, or gathering information for new designs. Probes are typically short-term projects of several weeks. The work of Clarke et al., in contrast, spanned several months, and revolved around issues of social justice, re-building identity, group discussion, and relationships. They fostered an open and long-term engagement to work on (individual) collections and displays of images in various (non-)physical states: printed, displayed on screens, and incorporated into videos.

A probe was designed in order to encourage the women to reflect on the things they saw as forming parts of their selves. It consisted of a digital camera, a sound recorder, a portrait frame, and a set of “inspiration tokens” and instructions meant to assist the participants in photographing or recording the aspects of their lives they wanted to share and/or retain. The tokens represented four main themes the women could include in their collections: people, sensory experiences, places, and objects (p. 2520). The research done in the early stages of the project revealed that it would be important for the women to create something they could take with them, something they could share both in the workshops and at home. This could help in building confidence, experiencing a sense of achievement, and affirming their agency.

Clarke et al. conducted ten sessions of two hours per week between November and February, with breaks for Christmas and school holidays. Initially, videotaping the sessions was planned, but the women were uncomfortable with that idea, so documentation of the process was done through anonymized fieldnotes (after each session), interviews with the women’s center staff, an outreach worker and the center coordinator, and a recorded group discussion (p. 2521).

In terms of the findings, Clarke et al. report that three qualities around the sociality of photo-sharing emerged through the process (p. 2521ff):

- *embodied expressions of relationships:* images taken of, with, or by friends; for example, on joint trips, illustrate their friendship. Two participants presented nearly identical photo albums showing images of time spent together on outings with the center, and their children. The images presented slightly different perspectives of the trips, with each woman carefully posing for the camera.
- *Balancing coming-together-ness with independence:* The women reported that the time in the workshops was a valuable chance to spend time with each other. Sharing photos in the group was even described as therapeutic by Samiya, the outreach worker of the center. The women also described the project as a means to think about their moving on and becoming more independent as well as sharing this process. Using photography and technology also gave the women a sense of independence and agency.
- *Negotiated sharing practices:* Carelessly shared digital content, for example, on social media, can become a tool of continued control and abuse in a context of domestic violence. Acknowledging the digital gender gap, women often need special help with their devices and online activity; for example, to keep their location safe from their abuser. Even in a safe space such as the workshop group, the women felt self-conscious about some images and the stories they told when put in context. Photographs of themselves, their families, personal places and objects were sometimes shared only after great thought was put into it.

The gender aspect of this project is visible in that while domestic violence can occur in relationships no matter the partners' class, age, religion, ethnic groups, genders and sexualities, the vast majority of serious and recurring violence is perpetuated by men towards women (p. 2517). Additionally, there is the above-mentioned digital gender gap, meaning that many women are less proficient and confident using various kinds of technologies.

Clarke et al. use gender as an analytical focus to restrict the population of their research, acknowledging that women who have experienced and survived domestic violence have different needs[15] as compared to people without these experiences.

What can we learn from this?

The first, most obvious lesson to learn from this project is: Remember that there are no "standard users". Life disruptions, and a hopefully good life thereafter, exist. (Clarke et al. 2013; Wachter-Boettcher 2017). Designs and research touching on such life disruptions, be they domestic violence, or loss of loved ones, has to be handled carefully. Assumptions about a stable family or personal life, for example, must be thoroughly examined (p. 2525).

In order to handle life disruptions with the appropriate sensitivity, Clarke et al. got in touch with the relevant experts for their participants, in this case, survivors of domestic violence, early on. For example, together with staff at the women's center, they examined the vocabulary they would use (p. 2519f), as well as the scope of the project (p. 2520), and the documentation of the project (p. 2521).

As seen in other case studies, and as recommended by Schlesinger, Edwards, and Grinter (2017), Clarke et al. provide readers with rich details on their participants, and how they got involved with the project: "[…] a self-selected group of six South Asian women who were aged between 25–38 and had been separated or divorced for between 1–6 years […]" (p. 2520).

Again, as the topic at hand is very sensitive, Clarke spent three months volunteering at the women's center before the project's sessions started, in order to get in touch with future participants, and to inform the research questions (p. 2519).

In order to facilitate participation, a lot of thought went into the timing of the sessions, and breaks for Christmas and school holidays were observed in order to avoid clashes with the participants' other commitments (p. 2520). Here, one should keep in mind the additional intersection of "women who are mothers and have experienced and survived domestic violence". Additional intersections, but also personal preferences, and in the present case, content created, can be reasons for diversity of needs within the pool of participants. Clarke et al. report that they themselves and the staff at the women's center had assumed the participating women would prefer similar levels of anonymity – but due to the different kinds of content created, different concerns were raised, and different types of anonymity were required (p. 2523). In short: even when people share many characteristics and experiences, their needs are possibly different. Needs may also include, for example, covering travel expenses and providing food during each session (p. 2520).

Knowing that photographs and the memories and emotions connected to them can present emotional challenges to those viewing them – especially in the context of domestic violence, the women's center offered free counseling for the participants during and after the project sessions.

As described by Schlesinger, Edwards, and Grinter (2017), self-disclosure of the research team is important. Reporting on your own background as a researcher provides further information on why methods were chosen, and why questions where framed a certain way. Self-disclosure furthermore highlights knowledge gaps between the researchers and research participants, who are the actual experts on their own situation. Finally, Clarke et al. (2013) use self-reflection to also reflect on the power imbalances and ethical challenges stemming from their position of power:

"[…] the importance of respecting diversity the women themselves would bring through their backgrounds and how these would differ from us as white middle-class researchers with limited experiences of domestic violence. Furthermore this meant reflexively acknowledging our positions in relation to power and ethics; who we are is not value neutral and being transparent about this position when approaching potential partners and participants was important in building relationships and trust" (p. 2519)

Case Study 5: Ahmed et al. 2014

Ahmed, Syed Ishtiaque, Steven J. Jackson, Nova Ahmed, Hasan Shahid Ferdous, Md. Rashidujjaman Rifat, A.S.M Rizvi, Shamir Ahmed, and Rifat Sabbir Mansur. 2014. "Protibadi: A Platform for Fighting Sexual Harassment in Urban Bangladesh." In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, 2695–2704. CHI '14. New York, NY, USA: ACM. https://doi.org/10.1145/2556288.2557376.

The Protibadi (a Bangla word meaning “one who protests”) project addressed a specific gendered issue, namely sexualized harassment and violence. The team, consisting of Syed Ishtiaque Ahmed, Steven J. Jackson, Nova Ahmed, Hasan Shahid Ferdous, Md. Rashidujjaman Rifat, A.S.M Rizvi, Shamir Ahmed, and Rifat Sabbir Mansur, created a platform where people who experienced sexualized violence could share these experiences. The paper documents the whole process of user-centered development of the web and mobile phone platforms. The project team conducted surveys, interviews, and focus group discussions at three different universities in Dhaka over the course of one year. The system designed to report, map, and share women’s stories around sexual harassment in public places launched in August 2013. Three months later, the website had 110 registered users (twenty selfidentified as men, the rest as women). The users had shared twenty-four reports of sexual harassment from different parts of Dhaka city.[16] Three months after the launch, the team examined the strengths and limitations of the system by conducting user studies and monitoring of public responses to Protibadi.

Ahmed et al. reference several projects spanning the world, as well as localized projects, for example, from Egypt, whose insights and design approaches they were able to build on. In addition, they contacted female university students in Dhaka in order to find out the women’s ideas about systems and applications that could help them. In the end, some features from different existing projects were combined into Protibadi: the user could quickly inform emergency contacts if they experienced a situation of harassment; they could document the location and nature of incidents, and they could post blog entries and thus share their experience with other users (p. 2697).

Ahmed et al. received 121 responses to their *online survey*, including 51 women, 42 men and 28 people who chose not to disclose their gender. Seven women and two men contacted the research team via email, phone calls, and personal encounters after completing the survey and provided further information. All of the 121 respondents stated that they had witnessed harassment of women in public places. All 51 woman participants additionally reported direct experiences of harassment in public places. Thirty-two women recalled experiencing either direct or indirect harassment more than once. The respondents agreed that public sexual harassment is a common and damaging experience of living in urban Bangladesh (p. 2697). The *focus group discussion* was conducted by a female faculty member at one of three participating universities. Thirteen women participated in the three-hour discussion. The women reported strong feelings of shame, sadness, and regret as well as defiance, anger, and a strong desire for change. In the *semi-structured interviews,* the women talked about their understanding and experiences of sexual harassment as well as their requirements and needs for design targeted at this issue.

The features requested and discussed included:

- *Help on the spot:* Many women said they wanted to alert bystanders to the harassment happening to them, in order to avoid, escape, or reduce the severity of the incident. However, the taboo surrounding sexual harassment also led some women to speak against this feature, as they anticipated feeling ashamed and embarrassed of receiving attention this way. Accordingly, in the user studies conducted three months after the launch, none of the interviewees had used the “Save me” button implementing this feature. Of the ten participants in the user studies, six said they would use it, while four said they would not in order to avoid embarrassment.
- *Reaching friends when needed:* In situations of harassment, it can be difficult to call friends and ask them for help, even if the victim has a mobile phone on them. However, all participating

women said they would feel better if they had a way of letting their friends know where they were.

- *Sharing Experiences with Others:* Again, all participants agreed that it would be important for them to be able to share their experiences anonymously and to receive support. In addition to feeling better because of the support the poster would receive, readers could use the information on the platform and decide whether to take any precautions based upon others' experiences.

Participants who had shared their experiences with others before (for example with family members and sometimes friends), experienced contradicting emotions of relief, but also deep embarrassment, anguish, and shame. These negative emotions were described as the most serious and pervasive consequences of their harassment experience.

The feedback collected in the *user studies* was positive, in general. Several interviewees noted the strong need for such a system, while being aware that it was only a drop in the ocean in relation to the omnipresence and seeming acceptability of public sexual harassment.

What can we learn from this?

As we have seen in other case studies, Ahmed et al. give detailed insight into who their participants are, and why they chose them: "Our choice of university women was dictated by three basic factors. First, most of them had access to technology like mobile phones and Internet, and so were more obvious first targets for an experimental system that made use of such tools. Second, in large part because of their education and socioeconomic standing, university women in Dhaka are often more attuned to problems of gender discrimination and sexual harassment, and more receptive to systems that combat it. Finally, as the inclusion of university-educated women in public life is often identified as a step towards gender participation and equality more generally, their exclusion from public space and participation through instances of harassment may be particularly insidious and damaging to the broader goals of gender equity and participation in public life" (p. 2697).

Ahmed et al. present several dimensions of intersectionality they deemed important for the success of the project. This occurs, for example, in the description of their participants, and in the discussion of future steps, where they mention an NGO planning to adapt Protibadi for rural areas with less mobile coverage, as well as a group wanting to extend it to include harassment in the workplace. Comparing Protibadi to other similar projects around the world, Ahmed et al. point out the need to consider a few localized differences, such as design metaphors, and assumptions, for example, about infrastructure (stable power supply, systems of law and governance), and the need for different modes of engaging locals. If work is done by non-local researchers, Ahmed et al. state that misunderstanding local culture and power structures could lead to non-adoption, suspicion, or plain indifference towards a project (p. 2696).

Having chosen a very specific target group, Ahmed et al. are aware that this focus creates limitations on the generalizability of their findings as well as the results.

Talking about the users of their platform, Ahmed et al. highlight that people self-identified as either women or men (see first paragraph). In their survey, in contrast, participants had the option to not disclose their gender. It is unclear whether users had the option to not disclose their gender on the platform, and whether there is inaccuracy in reporting, or inconsistency in data collection. It should go without saying that both inaccuracy and inconsistency should be avoided.

In their group discussion, Ahmed et al. tried to make their participants feel comfortable talking about sexual harassment. As some women did not feel at ease speaking about it, they were given the opportunity to write things down, and have them read for them by the woman who was conducting the discussion. This is also worth mentioning: all interviews and discussions with woman participants were conducted by women, and in rooms set aside for this purpose, to create a space where talking about this issue would not result in further embarrassment or shame. Audio-recording the interviews was the preferred documentation method for the researchers, but would only be done if all participants agreed. Furthermore, the participants could stop at any point of the interviews, request their data be destroyed, and walk out. One participant requested that her data should not be shared with male members of the research team, and in one case, an interviewee brought a companion who helped her share her story.

Case Study 6: Haimson, Brubaker, and Hayes 2014

Haimson, Oliver L., Jed R. Brubaker, and Gillian R. Hayes. 2014. “DDF Seeks Same: Sexual Health-Related Language in Online Personal Ads for Men Who Have Sex with Men.” In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, 1615–1624. CHI ’14.

New York, NY, USA: ACM. https://doi.org/10.1145/2556288.2557077.

Oliver L. Haimson, Jed R. Brubaker, and Gillian R. Hayes studied the language used by men who have sex with men (MSM) to pass on information relating to their sexual health in online personal ads.

This research can be placed in the area of HCI, as linguistic analysis can build a foundation for system architecture, and it can help in understanding how users (re)present themselves, and how they communicate. Haimson, Brubaker, and Hayes claim that similar methods of linguistic analysis couldbe applied to inform designers about how users “represent their health conditions, preferences, and activities” (p. 1622f). Their work provides a means to gain insight into HIV epidemiology as well as the discourse among specific communities.

In addition to the HCI scope, Haimson, Brubaker, and Hayes studied the temporal changes in SHR language used, for example, the (dis)appearance of phrases and words, and the increase of SHR language present in ads. They argue that the content of online personal ads may be used in STD research and prevention efforts, by making visible the local prevalence of STDs (p. 1615, p. 1623).

The team used open-coding techniques to find the sexual health related (SHR) language that MSM used on Craigslist personal ads. They collected 252,786 “men seeking men” (m4m) ads within a two-week period in August and September 2013 from all over the United States. A team of four coders, including two “gay-identified men” (p. 1618), coded a sample of 500 ads in total to build the dictionary for the study.

What can we learn from this?

The language used by Haimson et al. to describe their target group (“men who have sex with men”, or MSM for short) is exact, and concise, while not excluding/erasing anyone. The terms “homosexual men” or “gay men” on the other hand would exclude bisexual men.

Again, we see an instance of self-disclosure, describing the coding team: “[f]our coders, including two gay-identified men” (p. 1618).

Haimson et al. explain in detail how and why age groups were constructed, taking into account the specific history of HIV/AIDS (p. 1620). Categories are defined, for example, based on the user’s phase of life during the 1980s, when most people learned of HIV/AIDS (and thus, whether or not they were most likely sexually active at that time). Other groups consist of those too young to remember the HIV/AIDS epidemic, who may display more risky behaviors than older men (p. 1620).

Case Study 7: James DiSalvo et al. 2011

James DiSalvo, Betsy, Sarita Yardi, Mark Guzdial, Tom McKlin, Charles Meadows, Kenneth Perry, and Amy Bruckman. 2011. “African American Men Constructing Computing Identity.” In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, 2967–2970. CHI ’11. New York, NY, USA: ACM. https://doi.org/10.1145/1978942.1979381.

Betsy James DiSalvo, Sarita Yardi, Mark Guzdial, Tom McKlin, Charles Meadows, Kenneth Perry, and Amy Bruckman developed Glitch Game Testers, a program to introduce low-income high school students with an interest in video games to work in computing. They state that in general, although African American men are passionate about video games, they are less likely to take an interest in the technology behind these games. This is possibly connected to how African American identity is constructed in stark contrast to being a "geek", "nerd", or "tech person": while African American identity is strongly connected to the body, athletics, and sexuality, the stereotypical hacker is depicted as ignoring the body and appearance. Comparable to how women cannot or only rarely see themselves as hackers, this mismatch in physical identity can lead to the disidentification, and thus rejection of (in this case) computing as a field of interest and future occupation.

To tackle this issue of participation and socioeconomic equity, James DiSalvo et al. developed a job training program to educate young African American men to "break open the black box" of games to learn about computing. Participants receive an apprenticeship as game testers working full-time during the summer, and part-time during the school year. Their task encompasses quality assurance for pre-release games from game companies such as Yahoo!, Electronic Arts, and Cartoon Network.

To measure effects of the program, pre- and post-test surveys were conducted with twenty-one Glitch participants. Students joining the program in 2009 were categorized as "oldtimers", those joining in 2010 as "newcomers" in the study. The survey measured the participants' perceptions of technical competency for both their peers and themselves, and the access to technical resources in their social groups. The pre-test was completed in the first week of the summer 2010 program, the post-test was administered eight weeks, about 280 working hours, after the pre-test in the last week of the summer. In addition, interviews and focus groups were conducted, and researchers spent over 800 hours finding, observing, and engaging with participants.

For the survey, participants were asked to list close friends and close family members, and to rank each person based on perceived technical expertise as well as four people they would go to for help if they had a question relating to computers and technology. For both lists (technical experts, and technical resources) they were asked to report relationship, closeness, and technical expertise of each connection. DiSalvo et al. report that participants were more likely to see their peers as technical resources after participation in Glitch than before, and that participants' overall access to technical expertise increased significantly. Results for participants' perception of their own technical expertise showed a much higher difference between oldtimers' pre-test and post-test self-ratings than those of the newcomers.
DiSalvo et al. also report that oldtimers' self-ratings increased while newcomers decreased slightly (both not significantly).
In past evaluations, qualitative and quantitative results also suggested an overall positive impact on participants: five of the seven participants who graduated from high school in 2010 went on to attend college, and selected computer related majors. Of these students, only one had thought of going into computing before working with Glitch.

In conclusion, James DiSalvo et al. suggest that peer influence (for example influence oldtimers have on newcomers) can have positive impacts on technology adoption and identification. They make the following proposals for projects similar to Glitch Game Testers (p. 2970):

1. In order to motivate adoption and desire to learn among newcomers, pair them with oldtimers.

2. Changing the image of a technology within a social group can make knowing it more socially desirable ("cooler", so to speak). Thus, introducing new technologies, especially those that require learning and acceptance of new users, may become easier.

3. The technical capital survey developed by DiSalvo et al. may offer an approach for HCI researchers to measure social stigmas among users or individual and group attitudes in various domains.

Their advice that "future research should consider social norms and group identification in the design process" (p. 2970) is an important lesson to take into any design process, no matter the domain.

What can we learn from this?

James DiSalvo et al. state that when recruiting participants, they did not explicitly include gender and race in their selection criteria. Instead, the entrance criteria were that students come from low-income households (measured by Free and Reduced Lunch eligibility) and express an interest in video games. All applicants who met these criteria happened to be African American young men – think about how intersections can change the direction of your project. Rather than being very strict and focused from the beginning, instead, think of "marginalized groups", look at factors other than gender first!

James DiSalvo et al. highlight how identities are constructed, and what happens when one's self- image and the image of a hobby or activity do not fit together (disidentification). They explicitly account for how masculinity differs by culture, contrasting White men who can easily identify as nerds, and Black men, who cannot.

Combining the knowledge of constructed identities and the intersectional lives of their participants, James DiSalvo et al. found an appropriate way to make computing interesting to them. In order to pave the way for newcomers into computing, projects often try to make it "fun" and "easy" and use elements of gamification. With Glitch Game Testers, participants had the opportunity to see computing as a desirable future occupation, and as something they CAN do.

Some details in the paper could be improved. For example, the term "male" is used when talking about gender, rather than "men". As discussed above, when talking about gender, "man" and "masculine" are the more appropriate terms. Furthermore, additional information on the project's context would help readers gain a better understanding. For example, information on the student population at the participants' school(s) would underline the reported impact on college enrollment.

Outside Academia

As Human Computer Interaction is not solely an academic field, a great deal of research and development also happens in the industry. Thus, it is only reasonable to also look into the industry to see how gender factors into design processes and decisions, and how disregard of gender dimensions can cause product failures.

For this insight into the industry, I have found examples in the work of Sara Wachter-Boettcher (2017), Caroline (Criado-Perez 2019), and Carol Reiley (2016).

Ignoring the gender dimension in product design and development can lead to strange outcomes. While it has been possible for users to track all kinds of aspects of their life and body functions since Apple first introduced the Apple Watch, tracking one's menstrual cycle was only added as a feature in 2019.[17]

Reiley (2016) reports that Mattel's "Hello Barbie" was initially not able to understand its prime target group (little girls). Similar issues of voice recognition failing to recognize feminine voices are reported by Criado-Perez (2019) in the setting of voice-controlled, on-board computers in cars. Both can be traced back to the fact that voice recognition software is often trained only on adult's masculine voices. Another, rather infamous product of slanted training and test data happened to Google Pictures, when some users realized it tagged Black people as gorillas – which is a symptom of the test and training data sets basically not containing enough pictures of Black people to distinguish them from gorillas (Wachter-Boettcher 2017). Google's "solution" to this issue was to simply delete the tag "gorilla" from the software.[18]This issue is not limited to Google alone: Microsoft and HP software for facial recognition had difficulties recognizing non-White people,[19] and Apple's FaceID had issues telling apart Asian women.[20]

While these failures sound pretty much like "first world problems", the data sets and software packages causing them are not used only for harmless things like toys and handy features like tagging images – they are also being used to teach self-driving cars, and security/surveillance systems with facial recognition. These surveillance systems often have their best results in exactly one category: White men; the worst performance has been reported for Black women (Buolamwini and Gebru 2018).

Disregarding gender dimensions affects not only software, however. Physical systems have similar issues, based on the history of design where men have long been centered in research, and their bodies accepted as a default. Instances of physical designs disregarding women are smartphones and other hand-held devices that are too large for small hands, or fitness trackers that cannot track movement/workouts when users are pushing a stroller (Criado-Perez 2019).

What can we learn from this?

The most important lesson to be learned from the incidences mentioned above is to be critical of the things you use, whether data sets, parts of software, or full applications. Try to find out what the people behind your resources had in mind, and where they might have overlooked something. Think outside your (and your colleagues') box, find stress cases (Wachter-Boettcher 2017) and try to handle them well. Ask yourself whether things have to be done the way they have been done.

Try to consider the situatedness of knowledge (Haraway 1988). For data sets, whether they are statistical data for mining information, or survey data from user studies, regard how they came to be. Where did the user study take place? When? Who was interviewed? What was the context of the survey? What cultural, temporal differences might change the outcome of a similar survey if it took place now and where you are located?

Discussion and Recommendations

This section consists of a summary of the lessons one can learn from the case studies presented above, and specific recommendations for both research funding organizations (RFO) and researchers. I illustrate each detailed recommendation with examples from the case studies above, and where available, provide further interesting reading material.

The most basic, but probably hardest, thing to do is to be aware of the gaps in your idea, data, and plans, and try to mend them. Finding those gaps can be difficult if you talk only to people from your own domain; finding experts able to look at whatever you are trying to do from a different perspective is helpful. For starters, have a look at the GenderMag method (Burnett et al. 2016), which offers help

finding gender inclusivity bugs in software, or read about how forms and databases may exclude or include people who do not fall into a cis gender binary (Spiel, Keyes, and Barlas 2019).

Based on the recommendations below, a Gender Inclusiveness Checklist along the lines of ethics checklists such as the Horizon 2020 ethics self-assessments may be established. I will investigate this path in the context of future research.

Include Gender Studies and Intersectionality Basics

Both researchers and RFOs should learn about, and could mention in project documentation, some basics from the fields of Gender Studies and Intersectionality. This would clarify for readers what your work is based on, and some may even learn something new. In addition, it would contribute to the normalization of gender studies in CS.

Cues to follow are, for example, the point made by Otterbacher (2015) that there are more than two genders, and more sexualities than just hetero- and homosexuality;[21] or the short discussion on the construction of identity by James DiSalvo et al. (2011).

Remember the normative impact of language

Use inclusive language to avoid perpetuating exclusionary stereotypes. For example, use singular they when referring to "abstract" users, state all options and choices when presenting statistics ("45 % identified as women, 44 % as men, 7 % as non-binary, 4 % chose not to disclose their gender"), and consider not using "traditional" defaults (for example, order sexuality by alphabet, ranking "asexual" first). Further, use participants' self-descriptions and preferred expressions (Blackwell et al. 2016), refer to experts to check one's vocabulary and assumptions (Clarke et al. 2013), and use inclusive terms (Haimson, Brubaker, and Hayes 2014). Finally, use accurate language, and the correct terms to refer to sex and gender respectively. For details, see the discussions on Karuei et al. (2011), Ahmed et al. (2014), and James DiSalvo et al. (2011). When talking about participants' gender, make explicit what gender(s) you talk about – and do not assume your participants' gender, but explicitly ask them.

Research funding organizations (RFO) should, when reviewing calls and applications, pay attention to details. Being a linguistics specialist is not necessary; looking for the small things is a first step. For example, in Haimson, Brubaker, and Hayes (2014), there is no indication whether they found ads posted by transgender persons, whether they were included, or why they would have been excluded from the corpus.

Provide rich information on context

With a profound understanding of the context, readers and people building on your work can better understand your choices. Explain why you chose to include gender in your research,[22] and why you decided (not) to break the binary construct of gender. Discuss the origin of pre-collected data you use for your study – for example, workplace environments probably have changed over the past thirty years. Make explicit what you base your work on, so your readers can contextualize it, or even learn something new (as seen, for example, in James DiSalvo et al. 2011 discussing the construction of identity).

For both researchers and RFOs, this means: keep your eyes open, widen the horizon of your project. Specific men's issues exist, for example, inaccessibility of emotional/medical/mental health issues, taboos surrounding certain jobs or topics, etc.

No matter why you did it: using gender without explaining the motivation is not acceptable. RFOs should request further information from projects that use gender without any explanation. It should be clear why gender was included, and why the researcher(s) decided to build on a certain definition (binary, biological, self-identified, etc.). Basing research only on gender, without any further information about the participants, is highly questionable, and should thus not be accepted without further explanation.

As a researcher, in order to be sure that one does not overlook any important influences on users and their usage of technology, detailed information on one's participants as well as a study's context, the source of the data used and the binning of variables are essential.

Discussing the intersections making up the participants' identities and influencing their access to and use of technology can be seen, for example, in Blackwell et al. (2016), Clarke et al. (2013), and Ahmed et al. (2014). Reporting the context in which the project has been/will be conducted helps in understanding the project, its development, opportunities, and limitations. When using pre-collected data for a study, considering the context this data was created in, as described by Otterbacher (2015) and Haimson, Brubaker, and Hayes (2014), can be very revealing. Finally, making clear how results were grouped, and why, affects statistical analysis outcomes and interpretation (see Haimson, Brubaker, and Hayes 2014).

As a researcher, writing out these things will help you recognize if you, or the people whose work you build upon, missed anything of interest.

In the papers discussed in this work, some of these intersections were:

- the selection criteria of liking video games and stemming from a low-income home, which resulted in mostly African American young men being recruited for the project (James DiSalvo et al. 2011)
- self-identifying as LGBT and being a parent (Blackwell et al. 2016), who also discuss differences for LGBT parents in rural vs. urban settings
- the specific subgroups of women who are (perceived to be) heterosexual, and men who are (perceived to be) gay in Otterbacher (2015)
- the very diverse needs and personal groups within the rather specific group of domestic violence victims, which led to differences in technologies used, and contents shared in Clarke et al. (2013)
- in their work on Protibadi, Ahmed et al. (2014) note great differences in the perception and (non-) acceptance of sexual harassment in different cultures, but also within Bangladesh depending, for example, on the rural/urban, and workplace/public space dimensions.

As the last two points make especially clear, taking intersectionality into account means that there are no standard users. Finally, another important thing to do is to report on a project's limitations. Make absolutely clear who you are talking about. Which men, which women do your findings apply to?

Make your project accessible

Making research more inclusive is not always easy, and comes in many different shapes and sizes. However, it will make it possible to work with people who were not enabled by the circumstances until now, even if they had wanted to be part of research and development in HCI.

Researchers should remember to think about life outside their project and their institution. It is important to rank all hindrances on the same level, or at least make clear why one facilitation was deemed more important than another.

This begins by actively including people who are not the ubiquitous standard (mostly white, able- bodied men), and goes all the way to offering lunch during workshop days and tweaking the project schedule to accommodate for care responsibilities (Clarke et al. 2013), as well as making counseling available for participants (Clarke et al. 2013; Ahmed et al. 2014). Ahmed et al. (2014) also made various efforts to make their participants comfortable talking about a sensitive topic: participants could choose their interviewer, they could stop their interview at any time, and were also informed that they could subsequently withdraw their consent to data use.

Of course, in order to make your participants feel at ease, you need to find participants in the first place. For example, a team member of Clarke et al. (2013) spent some time volunteering at the women's center to gain the trust of the women spending time there. James DiSalvo et al. (2011) contacted schools and put up flyers there, and Ahmed et al. (2014) used the social media groups of local colleges. In short, as a researcher, one must find places the target group frequents. It should be clear from the start that one is looking for participants, and that the research team will try their best to accommodate the participants' needs. Contacting advocates, representatives, and other experts, such as the women's center's staff will provide initial insight into the needs and requirements your participants might have, allowing you to plan for their accommodation early on.

Funding organizations should take on the role of enablers for inclusion. For example, the availability of funding for childcare for study participants or counseling for participants and researchers could be made explicit in calls, forms, and other documentation. This might even encourage and inspire researchers to look at new target groups to do research on. Having a more inclusive mindset can also have positive impacts on the diversity of research teams, which in turn can improve the teams' research outputs.

Make methods accessible

Often, we build our work on great existing concepts and research. However, all predecessor technologies have been developed in and for certain contexts, so sometimes it will be necessary to make adaptations. In short, you need to be aware of the participant's perspective on the method(s) you want to use.

In the case of Clarke et al. (2013), the preparation time with the center's staff also led to adaptations to the original research plan. Clarke et al. (2013) decided to stick to the concept of cultural probes, but to rename them "digital portraits" to make the concept more easily approachable for their participants.

And while many projects that aim to include underrepresented groups in programming try to do so by making it more fun, James DiSalvo et al. (2011) managed to find a way to show African American teenagers that coding was something they could pursue as a career.

Consider the position of the research team

As pointed out by Haraway (1988) and Harding (2015), one's identity affects the information and knowledge one has access to, or how we see the world, and what we get to see of it. Thus, it is important, and also recommended by Schlesinger, Edwards, and Grinter (2017), to disclose some information about the author(s) of a paper or the project team. As seen in Clarke et al. (2013), this means reflecting power imbalances, and recognizing that one might not know as much about the user's desires as one thinks. Or, as seen in Haimson, Brubaker, and Hayes (2014), it can mean disclosing that a certain topic hits "close to home". As discussed by Schlesinger, Edwards, and Grinter (2017), self- disclosure should not be forced upon individuals, as disclosing information about oneself might have negative consequences – the world we live in, after all, follows rules that are often (among others) ableist,[23] sexist, and racist. All in all, it is important to consider one's position towards the research topic. If, how, and to whom this position is disclosed, should be decided individually. Sharing some information with participants can help build trust, while the same information may not be necessary or appropriate for a write-up.
Brulé and Spiel (2019) discuss the influence of the researcher's position in the context of participatory design. Their idea of systematic reflexivity, however, could be applied in other contexts.

Enabling thorough discussion and reflection

To do all, or even some of the above, takes time. People need the time and space to ask and discuss (sometimes rather difficult) questions. I hope that the present work makes it easier to find the right questions to discuss. RFOs can make this work (and the card deck I plan to create based on it) available with their calls, and request applicants to apply it.

One means that can be used to facilitate discussion and reflection is the deconstructive "mind scripting" technique described by Allhutter (2012). The technique is used to encourage people to try and remember why things were done how they were done, especially in settings where gender and technology "comaterialize" (p. 684).

I am aware that some of the recommendations can be difficult to implement, and that these difficulties vary between projects. My own experience from discussions with researchers at TU Wien have revealed that often intersectionality is not a known framework, and people do not even know where to start when they have to describe the "gender dimensions" of their projects, as is often requested by RFOs. I hope that this work will make it easier to get started with the topic.

All of the recommendations listed above can, of course, also be applied in industrial research. It may be an unpopular opinion, but I think that giving people more time to develop their ideas, to discuss their motivations, and to reflect upon their work, will ultimately make for better artifacts.

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Review

Literature Review: Gender and Mobility

Tobias Lehmann

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Contents

Feminist Discourse on “Gender and Mobility”

Tobias Lehmann

Introduction

“Gender and mobility” is a long-standing field of scholarship and action among feminist researchers and practitioners whose beginnings date back to the late-1970s (cf. Law, 1999; Sánchez de Madariaga, 2013a; Loukaitou-Sideris, 2016). Scholars and practitioners from a variety of fields, such as transportation research, geography, urban studies, sociology, architecture, and planning, have meanwhile analyzed differences in the travel behavior of men and women, as well as features of the built environment associated with this behavior and the ways they restrict or encourage particular mobility patterns. Such differences have been associated, to a great extent, with men’s and women’s everyday activities; related social/gender roles; typical life courses; and the social organization of production and reproduction, in general. With the emergence of the “second wave” of feminism in the 1960s, which began as a social movement in the United States, a gendered division of labor, which entails women’s unequal opportunities to participate in the labor market and thereby in public life was subject to increasing critique. The topic of “gender and mobility” thus comprised a particular component of a broader stream of feminist critique and was handled parallel to works on a range of issues seen as indicating patterns of patriarchal oppression (McDowell, 1993a). Since the bulk of this research was carried out in urban settings of the global North, for quite some time it had a very specific focus: namely, white, middle-class households, characteristic of the post–World War II period. In the global North, in particular, an increasing participation of women in the labor market called into question predominant spatial arrangements of the gendered division of labor, the separation of private and public spheres, and corresponding architectural and urban designs. Picking up on feminist critique already formulated in other disciplines, during the 1980s, a significant body of work developed in the fields of human and transport geography (e.g., Monk & Hanson, 1982; Pickup, 1984; cf. McDowell, 1993a; Law, 1999) as well as in disciplines dealing with the built environment, such as architecture and urban planning (e.g., Hayden, 1980; Matrix, 1984; cf. McDowell, 1993a). More recently, with the advent of “gender mainstreaming” in the mid-1990s, the topic of gender and transport has received broader societal uptake as a policy and planning issue (cf. Grieco & McQuaid, 2012; Roberts, 2013; Sánchez de Madariaga, 2013a, 2013b). While some scholars have noted an apparent decline in interest in “gender and transport/mobility” (e.g., Hjorthol, 2008), and “gender and planning” (e.g., Rahder & Altilia, 2004), others have noted policy and development agencies’ active interest in the topic, which has led to the production of a sizeable grey literature (comprising empirical studies, programmatic statements, practical “toolboxes,” and good practice examples). However, this frequently occurs outside of academic publication formats (Grieco & McQuaid, 2012).

This report aims to provide an overview of main topics, discourses, and lines of argument dealt with in feminist discourse on “gender and (physical) mobility.” In this, key orientation was provided by already existing reviews of the literature, notably, on the fields of feminist (urban) geography (McDowell, 1993a, 1993b; Bondi & Rose, 2003; Little, 2007), and travel research and transport geography under the header of “women/gender and transport/mobility” (Law, 1999; Hanson, 2010; Loukaitou-Sideris, 2016). Furthermore, one explicit aim was to include practical guidelines in the report (included in section 4), to provide further resources for researchers and practitioners. The relevant bodies of literature connected to the topic “gender

and mobility" are vast, in particular when considering the whole spectrum of "theory and practice" that feminist discourse and action aim to address. Thus, the overview provided in this report does not aim to be comprehensive, but is meant to introduce the paradigmatic lines of argument and cross-cutting matters of concern in feminist discourse on "gender and mobility." Doing so, the overview is restricted to discourse on "gender and mobility" as represented in English-language literature, and overall its focus is on arguments as they have been developed for the most part with reference to urban settings, and mainly in the global North (though some references are also made to literature that deals explicitly with specifics of the situation of women in so-called developing countries).

The report is structured as follows: after a definition of the key terms focused on in the report ("gender" and "mobility") (1), in the subsequent sections I explore several of the paradigmatic lines of research in feminist discourse on "gender and mobility." First, studies by travel researchers on differences in men's and women's mobility patterns and behavior (2), which may be considered initial founding elements for a broader feminist discourse on gender and mobility. Drawing on work done in the fields of feminist (urban) geography and urban studies, architecture, and planning (3), I then outline discussions on the gendered nature of urban space and its spatial division of labor (a), the notion of "geographies of fear" as conceived early on, as a critique of patriarchal oppression restricting women's free movement in public space (b), and conclude the section by hinting at further developments in feminist discourse on "gender and mobility," pointing to an area of research associated with "the new mobilities paradigm" (c). While these developments may, in part, be associated with the more academic strands of feminist discourse, the next section will then sketch out some of the main developments of discourse on "gender and planning" (4), thus turning towards the practical implications of feminist engagements as they relate to "gender and mobility." After a brief introduction to feminist planning theory (a), the notions of "cities of everyday life" and the "mobility of care" are presented as conceptual orientations in the planning of more gender equitable (urban) environments (b). Finally, the last sub-section discusses the notion of "gender mainstreaming" as major contemporary successor to earlier "gender planning" approaches which is frequently taken as a major leverage point for the implementation of gender policies to improve the conditions of women's everyday mobility This section also includes a listing of resources to provide practical guidelines, best practice examples, gender audit and impact assessment methodologies, and other related tools (c). The report ends with a concluding section summing up and sketching out main coordinates and tensions in feminist discourse on "gender and mobility," and pointing to needs for further research.

1. "Gender" and "mobility"

In the context of this report, mobility refers to the physical movement in geographical space, i.e., "physical mobility," as it takes place in everyday life, enabled by various means of transport and corresponding infrastructures embedded in the built environment. What is thereby not explicitly referred to in this report are phenomena such as social or occupational mobility, migration, student mobility, or virtual mobility, although these can be connected in various ways to the issues under consideration. More specifically, the field of research in focus here lies at the intersection of travel research and transport geography, human geography and feminist theory more broadly. In an attempt to formulate an integrative research program, Robin Law (1999) has introduced "daily mobility" as the proper object of study for feminist scholarship which "incorporates a range of issues central to human geography, including the use of (unequally distributed) resources, the experience of social interactions in transport-related

settings and participation in a system of cultural beliefs and practices." (Law, 1999, p. 574) Hence, not only quantifiable differences regarding observable travel patterns of women and men are of interest, but in principle, the whole range of individual experiences and sociocultural framework conditions associated with varying travel behaviors. In this sense, in a more recent collection on Gendered Mobilities, Cresswell and Uteng (2008, p. 2) offer a definition for a "holistic understanding of mobility": "By mobility we mean not only geographical movement but also the potential for undertaking movements (motility) as it is lived and experienced – movement and motility plus meaning plus power. Understanding mobility thus means understanding observable physical movement, the meanings that such movements are encoded with, the experience of practicing these movements and the potential for undertaking these movements."

Gender, as an analytical category, may then highlight various aspects relevant to the mobility behaviors of men and women. Roughly four ways in which the notion of "gender" comes into effect in feminist literature on gender and mobility can be distinguished, paralleling the varying meanings attributed to gender in feminist discourse at large (cf. McDowell, 1993a, 1993b; McDowell & Sharp, 1999, pp. 104–109, 132–134). In its first and most basic sense, "gender" is used to contrast the term "sex": "Whereas sex depicts biological differences (male and female), gender describes socially constructed characteristics (masculinity and femininity)" (McDowell & Sharp, 1999, pp. 104–105). That is, instead of ascribing natural characteristics to men and women (e.g., associating men with dynamism and mobility, and women with stasis and immobility), these are seen as historically contingent, and locally specific, "social inventions" that are (can be) subject(ed) to change and variation. Social constructions of gender may then, secondly, be analyzed in terms of gender relations, that is, as embedded within a broader societal context, referring to the structural aspects of social order (expressed, e.g., in the notion of "patriarchy"). In this perspective, gender is linked, for instance, to the social division of (paid) productive and (unpaid) reproductive labor (with men as workers and women as caretakers), or to the normative framework of heterosexuality suggesting more and less privileged forms of life (e.g., the "nuclear family" as a defended cultural ideal, as against social arrangements deemed to "deviate" from that presumed norm). Finally, (gender) identity links the category gender to conceptions of difference, sense of self, and performativity. In this way, gender may be associated with a late-modern abandonment of traditional social roles and norms further complexifying the underlying male-female binary often implied in theorizations of gender and gender relations: "Whereas older theories of identity posited a stable and core sense of self, often closely tied to differences of social class, recent theories have asserted the possibilities and problems associated with a more 'hybrid' (unstable, mixed, and multiple) notion of identity, often conceptualised in highly voluntaristic terms as part of an individual 'lifestyle' choice." (ibid., pp. 132–133) Insofar as gender identity complicates conceptions of women and men as homogeneous social (and biological) groups, it may furthermore be linked to the concept of intersectionality that has been employed to draw attention to the intersection of different markers of identity and social inequality, such as class, ethnicity/race, age, and sexual orientation. In terms of power relations and access to resources, this implies multiple layers of privilege. For instance, in Western societies, on average, white men may be seen as more privileged than white women, but white women may still be more privileged than men of color, and the latter still more than women of color, and so on. In spatial terms, then, the notion of intersectionality directs attention to the exclusionary effects of specific spaces and their cultures, while at the same time it rejects an essentialist "adding up" of different structural categories that would determine in a definite way the experience and social position of the people to whom certain categories may be applied. Thus, "although our identities as individuals might be multiple and fluid, power operates in and through the spaces within which we live and

move in systematic ways to generate hegemonic cultures that can exclude particular social groups such as women, Deaf people, lesbians, gay men, and so on" (Valentine, 2007, p. 19).

In feminist discourse on gender and mobility, theorizations of gender, gender relations, gender identity, and intersectionality, play a role to varying degrees, albeit with different emphases in different strands of research. For instance, in feminist human geography the discussion has increasingly moved to considerations of diversity and difference among women (and among men), and between women and men in different locations. In particular, qualitative approaches may allow for fine-grained considerations of, e.g., subjective (travel) experiences, identity constructions, and respective gender performances. Much travel research and transport geography, on the other hand, operates with more structural differences between men and women and their respective travel behavior on an aggregate level, attesting to "the precedence that quantitative studies and travel surveys are given in transport planning," where "numbers are needed and categorizations need to be made whereby one category is strictly separated from another" (Joelsson & Scholten, 2019, p. 4).

2. Transport geography and "Women's Issues in Transportation"

Research on the relation between gendered everyday activities and mobility patterns goes back to the 1970s when feminist transport geographers and urban planners began to examine differences between men and women and their respective travel behaviors (Law, 1999). In 1978, the first conference on "Women's Travel Issues" was held in the United States, which is still the largest international, conference devoted specifically to the topic of gender and transport. The initiation of the first conference was, to a large part, linked to women's increased entrance into the labor market, and the "dual role" of worker and housekeeper that many mothers took on. A critique was formulated against ordinary planning assumptions according to which gender as a variable was irrelevant in the calculation of future infrastructural needs and a planning practice that was adapted to the travel needs of a male commuter with relatively simple movement patterns (from home to work and back) that didn't take into account the reproductive work women combined with their activities as part of the work force (Rosenbloom, 1978). Due to established land-use and zoning practices and suburban sprawl, a spatial division of productive (paid work) and reproductive labor (largely unpaid care work devoted to children and elderly that is consistently, statistically carried out mainly by women) was identified as putting disproportionate strains on women who, on average, had to handle a larger number of different activities during their day than men, combining household (e.g., shopping), caring (e.g., escorting), leisure, and salaried work activities (Rosenbloom, 2006). Commuting and the "journey-to-work," in particular, have occupied center stage in this line of research for a long time (cf. McDowell, 1993a; Law, 1999; Bondi & Rose, 2003; Hjorthol, 2008).

In this regard, for instance, consistently shorter work-trip lengths for women than for men have been observed, and accredited to, e.g., women's lower incomes (not being able to afford to travel longer distances), characteristics of the labor market for women (being employed in "traditionally female," i.e., service or office-related, and often part-time jobs), the effect of the division of labor within the household (where key responsibility on average is persistently allocated to women, forcing them to limit their time outside of the house), women's choice of mode of transportation (often characterized by use of public transport and limited availability of the car), or differential spatial distributions of women's and men's residential locations and

employment opportunities (Hanson & Johnston, 1985). By and large, then, a number of empirical findings around differences in men's and women's travel behavior, experience, and their relation to the transport sector at large have since been consolidated. Sánchez de Madariaga (2013a, pp. 47–48) summarizes these as follows: "The significant body of research carried out since the 1970s shows consistent and significant differences in travel patterns between women and men. […] Women tend to travel shorter distances in a geographical area close to the home; they make more trips; they travel for a wider variety of purposes, which differ to a greater extent than men's; they have less access to a car and are the main users of public transport systems; they cease driving earlier than men; they make more chained trips and more multimodal trips; their travel patterns tend to be shaped as polygons, as opposed to the commuting patterns from home to workplace prevalent among men; women are more sensitive to safety concerns and tend to self-limit their movements and activities in urban space because of perceptions of risk; women's smaller body size and strength have specific implications for the design of spaces, vehicles, and security devices that often are designed according to a standard male reference model; and many more men than women work in the transport sector, where the participation of women is particularly low in positions of responsibility."

Such differences in patterns of movement as the above-mentioned regularly appear as differentiating men's and women's mobility behavior on an aggregate level. At the same time, it is important to note that such differences may be aggravated or alleviated when more specific sub-groups of the population are compared. For example, it has been found that differences in commuting distances are much higher among women of color than among white women (Doyle & Taylor, 2000), and while in some places overall convergences between comparable groups of men and women (i.e., in terms of socioeconomic variables, life-stages) have been noted (e.g., in terms of the availability of a private car), there are still differences in mobility behavior according to sex, e.g., between households headed by either single women or men (e.g., in terms of time spent chauffeuring children) (cf. Rosenbloom, 2006). Crucially, however, regardless of how the travel behaviors of such comparable groups differ to a greater or lesser degree, it is held that the majority of men and women are simply not comparable, because of the high statistical correlation between sex and a gendered division of labor (i.e., women are significantly more likely to take care of children and elders, and to perform the majority of household tasks). It is then these gendered patterns of everyday activity that go along with different mobility patterns (e.g., trip-chaining) and associated travel needs. This then raises the question of not necessarily the extent to which men and women as such behave differently and the extent to which a given transportation infrastructure caters to this behavior, but instead, how it serves the different travel purposes of productive (i.e., waged) and reproductive (usually unpaid) labor more generally, regardless of who carries out the behavior (ibid.). Recent attempts to shift transport planners' focus from commuting to trips associated with a "mobility of care" (Sánchez de Madariaga, 2013a, 2013c; see section 4) attest to this more holistic approach to societal mobility needs, which, however, was never precluded by earlier research in the field: "It can be argued that we are not really talking about women's behavior when we talk about household or family travel behavior. Yet in a significant number of cases – for historical economic reasons or as the result of culturally defined roles that might eventually change, or simply because women are the majority of people in a group on which we are focusing – gender is the most salient behavioral reference available. In some cases gender may only be serving as a proxy for other variables but until we can gather data on those variables or easily quantify them, gender is still the most useful data we have" (Rosenbloom, 1978, pp. 349–350).

In terms of its institutionalization as a research field, the most important conference series dedicated specifically to gender issues in transportation is the "Women's Issues in Transportation" (WIiT) conference, which was initiated in the U.S. and took place in 1978, 1996, 2004, 2009, and 2014 when it was held for the first time outside of the U.S., in Paris, France.

The next date was September 2019, again in Irvine, California. Through the development of research in the area, the conference's agenda has successfully broadened. It also became increasingly international, with the 2009 conference beginning to address international differences between the global North and South, or so-called developed and developing countries, respectively (cf. Rosenbloom & Plessis-Fraissard, 2011; Roy, 2011). The topic of "sustainable mobility" was taken up in the fifth conference.[1] Marolda and Dupont, in a report commissioned by the European Commission, reconstructed the programmatic development of the conference series, starting from the fifth conference: "The Fifth Conference on Women's Issues in Transport (WIiT) focuses on bridging the gaps between men and women, between rich and poor countries, and between knowledge and policy. To this end, the conference is directed to identifying and addressing the issues at stake in the transport system to enhance women's mobility and to make transport more gender neutral. This conference builds on the achievement of previous conferences, the first of which in 1978 analysed women's travel behaviour and conditions. The second conference held almost 20 years later expanded the scope from primarily research to include policy-making, planning and engineering processes. In 2004, participants were invited from all levels – national, regional and local – in the public and private sectors. The fourth WIiT conference in 2009 was opened to a broader international audience and focused on personal safety and security, changing demographics, crash and injury prevention, and the impact of extreme events. A key outcome of the 2009 Conference was the decision to broaden the focus to gender-neutral transport rather than to focus solely on women's issues. Defining gender-neutral transport with respect to values, needs, choice, constraints, and impacts, concepts that vary significantly with place and time, requires international collaboration. This was the inspiration to hold the 2014 conference for the first time outside the USA, in Paris with the focus on bridging the gap" (Marolda & Dupont, 2014, pp. 3–4). While it has been noted that the field of transport geography at large has been somewhat resistant to incorporate insights from social theory and feminist analyses (Hall, 2004), gender issues in transportation have nevertheless found their way into the agendas of policy-makers and international development agencies. In this regard, the last two decades have, not least, seen an increase in reports and empirical studies commissioned by local and international institutions, often as background reports in preparation for various policy initiatives (e.g., Turner, Hamilton & Spitzner, 2006, in the EU context; Peters, 2001, 2011, for the UN; Duchène, 2011; Tiwari, 2014; Ng & Acker, 2018, for the OECD's International Transport Forum, ITF).

[1] The description of the sixth conference announced session tracks that will address "women's travel behavior patterns; transportation planning and policy processes to consider women's issues; women's safety, personal security, and health considerations in transportation; and women and emerging transportation technologies. The conference provides an update on the progress and challenges in relation to women and mobility; explores how gender equality practices in transportation are increasing business and economics development; exchanges ideas on how public agencies can incorporate good gender equality policies and practices with approaches to oversee efforts and measure performance; and examines methods to address safety and security of women who are employed with or using transportation systems." (http://www.trb.org/Calendar/Blurbs/175975.aspx (accessed: July 7, 2019)

3. Feminist geography, architecture, and urban studies

According to Law (1999), efforts in travel research initiated the now rather well-established field of feminist research on gender and mobility, by making visible quite large-scale regularities in the differences between men's and women's travel behavior: "Attention to transport offered a way to link discussions of gender relations, transport systems, public and private spaces, accessibility, and the spatial and temporal organization of human activity" (Law, 1999, p. 567). In turn, these findings initiated two main areas of research within a broader project of feminist geography particularly relevant to questions of daily mobility: one that emphasized women's fear of male sexual violence, particularly rape, as a major source of women's constrained use of public space, and another examining spatial divisions of labor and corresponding questions of urban design as factors accounting for men's and women's different uses of space and corresponding travel behavior (Law, 1999; cf. Bondi & Rose, 2003; Levy, 2013).

a) Cities, architecture, and spatial divisions of labor

In a foundational text, titled Making Space: Women and the Man-Made Environment (Matrix, 1984), the Matrix collective of feminist architects and planners critiqued dominant paradigms in architectural practice that were seen as incorporating male-centered, androcentric views of social relations, with the effect of inscribing traditional norms regarding the relation between the sexes into the physical environment of both individual homes, as well as urban space more broadly. Architecture, in this sense, "seems to make a physical representation of social relations in the way it organizes people in space. It does this both symbolically – through imagery and 'appropriateness of place' for a particular activity – and in reality – through physical boundaries and the spatial relationships made between activities" (Boys, 1984, p. 25). As the majority of architects were (and still are) men, prevailing arrangements were therefore interpreted to display specifically male projections of how social life should best be ordered. To open up architecture to new ways of thinking and design, a feminist analysis of architecture, according to Jos Boys (one of the members of the Matrix collective), would thus have to address three levels of analysis: "First the way in which the physical arrangement of the built environment can reinforce women's differential access to resources; secondly, the way in which the built environment simultaneously legitimizes and naturalizes that inequality; and thirdly, the way in which designers of the built environment consistently construct their own socialized experience as 'the norm'" (ibid., pp. 28–29). So, while the built environment was not necessarily conceived as unalterably determining social activity that takes place within it (Boys, 1984), it nevertheless was seen to manifest a material spatial order of relations between activities associated with production (wage labor) as against reproduction (usually unpaid care work), and with public as against private (domestic) spaces (cf. Hayden, 1980; McDowell, 1983; Matrix, 1984; Spain, 2002; Day, 2011): "The city has been shaped to keep women confined to their traditional roles as wives and mothers. Suburbs are built expressly for the family; job opportunities are few for many; the public transport system is geared for the movement of commuters in peak periods and it is difficult for women to cross between suburbs; public places equipped with revolving doors or turnstiles render the woman with a pram or pushchair a 'handicapped person' (Harman, 1983: 104)" (quoted in McDowell, 1993a, p. 167).

The Marxist distinction between reproductive and productive labor, which runs parallel to much of transport geographers' interest in the home-work-trip is central to 1980s feminist writing on the gendered spatial division of labor in the city. While urban structure was seen to favor men's participation in paid labor and public life, women's existentially vital contribution to upholding

social life and order seemed systematically neglected: “In the end, if the system still ‘works’ it is because women guarantee unpaid transportation …, because they repair their homes, because they make meals when there are no canteens, because they spend more time shopping around, because they look after others’ children when there are no nurseries, and because they offer ‘free entertainment’ to the producers when there is a social vacuum and an absence of cultural creativity. If these women who ‘do nothing’ ever stopped to do ‘only that,’ the whole urban structure as we know it would become completely incapable of maintaining its functions (Castells, 1975: 177–78)” (quoted in McDowell, 1993a, p. 166). The devaluation of reproductive labor carried out by women was pointed out on various scales, from the spatial structures of the house to the entire urban geography. In accordance with dominant social norms, these were seen to settle women’s subordinate position, restricting their options for alternative ways of life. Within the house, for instance, gender-relations were analyzed in terms of the arrangement of different rooms. “Male spaces,” such as the living room or the library, were found to be placed close to the entrance of a house, pertaining to the symbolic representational function of such spaces, easily visible to outsiders and guests; rooms designated to “women’s activities,” on the other hand, such as the kitchen or nursery, were often located “in the back” of a house, so that their work not only became less visible (thereby also symbolically devalued), but also frequently had to be conducted in rather unhospitable, small rooms sometimes even without windows or any (visual) connection to the outside world of the house (e.g., Boys et al., 1984). On the broader scale of the city, then, established planning practices of land-use and zoning were problematized, as reinforcing a spatial division of labor corresponding to the notion that “a woman’s place is in the home.” Exemplified by the model of the modern, industrial city, characterized by suburban sprawl on the one hand, and centralized industrial sites of production on the other, such a structure was held to reinforce women’s subordinate position on the labor market as well as their isolation in the individual home where they had to take on the majority of household and reproductive work (cf. Hayden, 1980; McDowell, 1983): “In a society which has been built around individual physical mobility, women are less mobile than men because they have less money, less access to transport facilities and more responsibility for other less mobile persons such as children and old people. Women’s lack of relationship to the sites of production (their amount and range of choice of paid employment) is thus intensified, both by this relative immobility and by the physical distancing of home and work generated by the decentralization of dwellings. [...] Physical space thus exaggerates the potentially isolating quality of taking sole responsibility for childcare and/or domestic labor in a privatized way” (Boys, 1984, p. 29).[2]

While these analyses attest, as mentioned before, to a time of intensified transition from a “family wage” to a “dual earner” household model, with women’s increased participation in the labor force highlighting the emergence of new ways of life that were seen as hardly compatible with hitherto seemingly self-evident social norms and design schemes, more recent developments in feminist theory as well as changes in the political economy at large have made the picture more complex. Thus, not only does the theorization of oppressive features of urban structure seem to have been carried out too strictly (cf. Bondi & Rose, 2003), but also the effects of neoliberal policies and their impact on socio-spatial relations have become increasingly visible and subject to consideration (Peake, 2015). In this way, not only have gender roles in the new global economy become more diversified (if not even, in part, neutralized), they also seem to have deepened global inequalities with differential impacts on women in different locales and social positions. In an ideal-typical contrast, as it were, urban

[2] “I suggest that the design of the built environment has maintained a consistent 'distancing' of women from sites of production (and for that matter from other facilities). This has combined with the general lack of access to

sociologist Daphne Spain (2002) discusses the differences between the classical model of the modern, industrial city with that of the "postmodern," informational metropolis, and the shifting gender relations that can be seen as contributing to those apparent changes in urban structure using the example of the U.S.: "The industrial city a century ago had one central business district, mixed land uses that juxtaposed slaughterhouses and tenements, high population density, and the vertical profile of smokestacks and skyscrapers. In contrast, the contemporary informational metropolis consists of multiple centers, single-use zoning, low density, and a strong horizontal axis […]. Most women's lives now include the home and workplace, which are separated by low-density, single-use zoning that contributes to suburban sprawl" (ibid., pp. 160–161). Accompanying this constellation of both changing urban landscapes, particularly the formation of edge cities, as well as women's overall improved societal status is not only an increasing demand for vehicles, mainly private cars – a pattern shared by men and women – but also, due to the rising costs of affording a middle-class life-style, an increase in both male and female members of a household taking on waged labor, leading to less available time for household and care-related tasks. Spain describes how vital "services once performed by women in the privacy (or seclusion) of the home have moved into the public arena: care of dependents and meal preparation," spawning more and more facilities devoted to childcare, assisted care for the elderly, and eating establishments (ibid., p. 163). As in the case of live-in domestic workers, these jobs are again either staffed mainly by women (McDowell, 2007) who generally find work predominantly in the service sector (Rosenbloom, 2006), or by other economically marginal groups, such as "immigrants, teenagers, or retirees – those who are marginal to the mainstream economy, just as women were when they prepared meals at home" (Spain, 2002, p. 164).

Childcare, for instance, which has become a key public and economic issue to compensate for women's increased labor market participation (Spain, 2002; McDowell, 2007), has thus spawned a new economy of "transnational care chains": as middle-class households are able to afford to pay service workers to perform childcare, this in turn leads to the question of who

> resources suffered by women because of their social 'place' in relation to the labour market and the family, to exaggerate women's isolated position in the social structure" (Boys, 1984, p. 29).

takes care of those women's children; that is, the children left alone while their mothers care for their employers' offspring. The case of live-in au pairs or nannies, then, can also help to illustrate a tendency of dissolving traditional associations between femininity, domesticity, and the home in the wake of a neoliberal political economy. These associations "are being challenged by active labor market policies that insist that the key social responsibility of the ungendered individual at the center of neo-liberal policies is labor market participation. Whereas taken for granted co-presence and co-sanguinity – in particular of a mother and her children – have long been the defining characteristics, indeed constitution, of the idea of a home, the home increasingly is a space marked by absence and/or by the co-presence of people united not by ties of blood and affection but by economic exchange" (McDowell, 2007, p. 130). As a consequence, "the old idealized public/private distinction embodied in liberal thought and in the establishment of the institutions of the modern welfare state in which a gendered bargain was struck in which men cared for their dependents through participation in the public world of employment and women provided nurture and care in the home has been disrupted" (ibid., p. 133). So, at the same time as new ways of life have become possible for some, old ones are preserved and partly delegated to less privileged social groups, corresponding to new divisions of labor, and distributions of resources and privileges that have

to be accounted for when considering novel gender relations and identities in their interplay with changing gendered geographies.

b) Geographies of fear/violence

Women's and men's different perceptions of risk and experiences of fear were a matter of concern for feminist scholars early on, and are considered important factors for understanding potential barriers to women's mobility and use of public space (cf. Loukaitou-Sideris, 2016). According to Law (1999), this strand of research stands out as a second major field of feminist scholarship that has shaped discourses on "gender and mobility" alongside feminist analyses of urban design and architecture associated with traditional, gendered divisions of labor. While at first the "geography of fear" discourse was centered around the question of women's oppressed status in patriarchal society, more recent developments increasingly diversify the picture, including fears associated with ethnic subgroups in connection with global migration movements (cf. Peake, 2010). At the same time, women's fear of violence can still be said to deserve special attention, particularly as the range of potential threats in comparison to those typically faced by men is extended to include that of (male) sexual violence, ranging from verbal or gestural harassment in public space to physical sexual assault, rape, or even sexual murder (cf. Bondi & Rose, 2003).

Gill Valentine, in her paper on "The Geography of Women's Fear" (1989), paradigmatically expressed in feminist discourse what is on other occasions frequently discussed as "spaces of fear," "fear of crime," or "spaces of violence." Valentine reported on her findings derived from eighty in-depth interviews and six small-group discussions with women living in a middle-class housing estate and a council estate in the town of Reading, UK. What she describes is a dynamic of male violence against women and personal experiences with such violent encounters (either first or second hand, or conveyed through media reports, or young girl's socialization processes and their parents' fear for their safety, resulting, altogether, in an increased awareness of being at risk when in public space). Although statistically women are at a greater risk of victimization in their own homes and by men they know, it is the perceived heightened unpredictability of strangers' actions that increases the sense of vulnerability in public space. While Valentine (1989, 1990; cf. Matrix, 1984) points to particular aspects of the built environment that may add to women's fear, or are more commonly associated with perceived threats, such as dark alleys, tunnels, signs of vandalism in the environment, or deserted parks; importantly, she also highlights social factors that may, or rather should be seen as the more fundamental causes of women's fear in public space. For example, familiarity with one's social environment, i.e., the inhabitants of an estate or neighborhood, may lessen perceived risks of violent behavior as it allows for the easier identification of strangers whose behavior is perceived as more unpredictable than that of residents. Also, it is reported that a sense of community increases the chances of receiving help in emergency situations. Furthermore, temporal aspects and the way in which the daily routines of men and women are structured are of great importance: in Valentine's (1989) study, for example, women move in public space predominantly during the day-time, due to the affordances of their working lives and household tasks. Men, on the other hand, often working full-time during the day, tend to occupy public space during the evening and night, hence increasing women's sense of being at risk especially in these hours. As the use of public space in this case is tightly coupled to employment patterns of men and women, the geography of women's fear that corresponds to such patterns, among other things, unfolds a vicious circle of restricted use of public space that poses further barriers to women's emancipation: "Women's fear of male violence does not

therefore just take place in space but is tied up with the way public space is used, occupied and controlled by different groups at different times. There is a vicious circle in operation. The majority of women still adopt a traditional gender role, and as a consequence are pressurized into a temporally segregated use of space. The subsequent control by men of public space in the evening means that despite the career success and independence gained by some women in the past decade (during which time there has been a significant rise in reported sexual and violent crime) the fear of male violence deters the majority of women from being independent. It robs them of the confidence to live alone, to work in certain occupations, and to socialize without a group or male chaperon. […] Consequently this cycle of fear becomes one subsystem by which male dominance, patriarchy, is maintained and perpetuated. Women's inhibited use and occupation of public space is therefore a spatial expression of patriarchy" (ibid., 1989, p. 389).

The geography of fear discourse has, throughout its course, been strongly associated with particular places and features of the environment that are seen to be connected to feelings of unease and insecurity. In this regard, many design solutions for situational crime prevention have been devised that may not only increase women's felt sense of safety, but also prevent crime in certain situations. At the same time, feminist discourse of fear in public spaces has developed ever more nuanced approaches to the issue, cautioning against simplistic notions of "designing out fear" (Koskela & Pain, 2000), at the expense of socio-cultural and political contexts that may be seen as more fundamental causes for many women's unease in public environments (such as a prevailing macho-culture, public neglect of issues of sexual violence more generally, or the prevalence of violence in private spaces that can contribute to a heightened sense of also being at risk in public spaces), and also against stereotypical constructions of women as inherently more fearful than men (Koskela, 1997). Furthermore, attention has been drawn to the fact that quite different places can be perceived as evoking fear, for instance, deserted open spaces, as well as crowded narrow ones (Koskela & Pain, 2000); and, finally, intersections between race, age, and gender have to be taken into account, where different subgroups can have quite different experiences of fear (Pain, 2001), with at times unexpected perpetrators, such as in the experience of veiled Muslim women in Malmö, who have been reported as frequently experiencing racist verbal assault in public by older women, as well as racialized physical violence by men (Listerborn, 2016). Therefore, with these complexities in mind, according to Listerborn who discusses recent trends in urban restructuring with an increased focus on women's safety, it is of great importance to understand which subgroups of the population (of women) are actually being addressed by relevant security measures. What she argues against is too narrow a focus on women as the only vulnerable group in need of protection, devised purely through technical design solutions, especially "when 'women' is taken to mean only white, middle-class and upwardly mobile women" (ibid., p. 257).

c) Gendered geographies and "new mobilities"

Both the spatial division of labor and the geography of fear discourse have been influential in the further development of deliberations on gender and mobility and gendered geographies and have provided important starting points for further work in feminist geography. These discourses have generally followed a trajectory along which a sole focus on women was increasingly broadened to include queer communities as well as considerations of intersecting axes of inequality combining factors of gender, race, age, and class. Furthermore, a bias of earlier work that tended to conceive of urban structures as generally oppressive, was

succeeded by more nuanced considerations that also examined possibilities for emancipation and the appropriation of public space by women as well as other hitherto marginalized groups, such as gays and lesbians (e.g., in the form of street parades, or gay bars and clubs allowing for performing sexual identities outside of the heterosexual framework). While previous work emphasized the structural constraints imposed on women by urban forms, scholarship increasingly highlighted the constitution of gender identity in the performative interplay of spatial structure and individual experience: “In very broad terms, concern with gender relations and gendered inequalities has been transformed by questions about identities, subjectivities and performances, which may be gendered but which are also marked by numerous other differences” (Bondi & Rose, 2003, pp. 231–232; cf. McDowell, 1993a, 1993b). Generally, “feminist scholarship in urban studies has thus indubitably established the centrality of gender to analysing cities and urban life. […] It has also influenced women’s studies by showing how space and place, as materially grounded social constructions, shape the ways gender identities and relations are played out, reinforced or modified. Urban form and process and locational differences within cities thus actively construct gender as well as other social relations” (Bondi & Rose, 2003, p. 232). The geography of fear discourse, in particular, “has thus moved away from questions of women’s experiences and behaviors ‘in’ urban space, to focus instead on the mutual constitution of gendered identities and spaces,” to “problematising a panoply of emotional experiences of which fear is but one, and in overcoming a polarity between viewing urban space as either constraining or enabling for women” (ibid., p. 234; cf. Wajcman [2010] for a parallel movement in feminist theories of technology).

What has been called the “new mobilities paradigm” in the social sciences and humanities (Sheller & Urry, 2006) has emerged parallel, as it were, to a general tendency towards poststructuralist theory and methodologies in more recent feminist scholarship (which is nonetheless contrasted by work orientated more towards structural features of the contemporary political economy, e.g., Fraser, 2009, 2016). While Law (1999) had already proposed broadening the agenda of research on “gender and mobility” as practiced in transport geography, the new mobilities paradigm seems to follow the same trajectory. Though not exclusively a feminist endeavor, the new mobilities paradigm shares many concerns with work in feminist geography. Also, more recent contributions to the field of gender, transport, and mobility explicitly draw on this recently emerged field of research (Cresswell, 2011; cf. Cresswell & Uteng, 2008; Clarsen, 2013). This has thus initiated an even further broadening of research questions and objects of study. Not only flows and movements of people and goods, but also ideas, images, cultural representations, information, bodies, forms of social life, technologies, and materialities of all forms, are analyzed – drawing mostly on theories and methods from the social sciences and humanities (cf. Sheller & Urry, 2006; Cresswell, 2011). For instance, as Sheller (2008) summarizes, discourses, geographies, and technologies and their role in shaping and being shaped by gendered power relations have been analyzed, disclosing, for instance, dominant associations of mobility with “[m]odernity, progress, and privileged forms of masculinity […] that not only define the West as mobile and expansionist, but do so through masculine figures such as the explorer, the entrepreneur, and the frontiersman” (ibid., pp. 257–258); religious and cultural norms, rules, and fashions that have enforced and fetishized women’s immobility (such as foot-binding in China, Victorian-era corsets, or modern-era high-heels), or the different socialization of boys and girls “in which boys have more latitude for movement, activity, travel across space, and risk-taking, while girls tend to be enculturated into more sedentary activities, more circumscribed uses of space, and greater risk aversion” (ibid., p. 259); as well as the gendered nature of many developments of

new (transport) technologies, where often producers, but also typical users are predominantly privileged men.

While feminist discourse and discourse on gender and mobility over the course of the last decades have both produced increasingly diverse perspectives, it is nonetheless important to note that these cannot be described in terms of a simple linear development, but rather, as the co-existence of various strands of scholarship. This is true for contemporary research on transport and mobility where, e.g., more quantitative and qualitative strands exist, as well as for feminist discourse where a broad range of perspectives on gender as an analytic tool has developed that serves as repertoire for further research, as well as planning efforts concerning gender and mobility (Joelsson & Scholten, 2019a; cf. McDowell, 1993a, 1993b).

4. Gender and planning

Already indicated by the title of the Matrix collective's programmatic Women in the Man-made Environment (Matrix, 1984), even early on, feminist critiques focused not only on analyzing differences between men and women as corresponding to their (urban) environments, but also on the very processes of decision-making and planning that bring about certain spatial and transport arrangements in the first place – as well as how to productively intervene in these practices. Particularly the professions of the built environment, urban and spatial planning, and architecture, as well as transport-related occupations have historically been dominated by men, a fact that has led to a criticism of the resulting, oft-diagnosed neglect of women's views and experiences in planning processes, and hence a systematic blindness vis-a-vis women's needs and practical demands (Sandercock & Forsyth, 1992; Fainstein, 2005; Roberts, 2013; Sánchez de Madariaga, 2013a; cf. Matrix, 1984; Moser, 1989). In particular, a tradition of rationalist planning embedded within gendered assumptions about women's role in society ("a woman's place is in the home"), oriented towards (economic) efficiency, quantitative methodologies, and informed by economic ideals of rationally choosing, self-interested actors, has since become the locus of feminist critiques (cf. Sandercock & Forsyth, 1992; Fainstein, 2005; Levy, 2013; Joelsson & Scholten, 2019a).

a) Feminist planning theory

In a broad stroke, Fainstein (2005, p. 121) characterizes the rational, economically-oriented planning model in the Euro-American tradition: "Despite differences in the locational outcomes of continental and Anglo-American planning efforts, in general, planning throughout the Western world sought to impose a rationality at odds with a sentimental view of human relations. First based in a purely physical conception of city development and then, after World War II, the application of social science methods, the male-dominated profession of city planning used criteria of order and efficiency to determine appropriate forms of spatial disposition. Building on a contractual conception of human freedom and legitimacy, planning, like political thought more broadly, did not consider the particular needs of women." This background opens up a stark contrast between rational planning models and the aspirations of feminist approaches to planning. According to Fainstein (ibid., p. 124), "In particular, the use of cost-benefit analysis that produced one favored outcome, reliance on quantitative indicators, and the application of hypothesis testing and regression analysis to planning issues all subordinated subjective feelings to measurable attributes. Further, they substituted a mechanical process (the rational model) for the evaluation of substantive results and of how those substantive results affected the most vulnerable groups in the population (Sandercock

and Forsyth 1992; chapter 4)." By contrast, "Feminism implies intuitive, participatory approaches to gaining knowledge and nonrational (although not necessarily irrational) contextual solutions to planning problems. […] Feminism introduces a perspective that starts with concepts of communal relations and incommensurable values, substitutes the development of consensus for adversarial approaches, protects the weak, and recognizes the importance of emotional bonds" (Fainstein, 2005, pp. 128, 129).

Sandercock and Forsyth (1992) note that since the 1970s, much attention had been focused on gender issues in planning practice, but connections to planning theory had been rather neglected, not least due to the difficulties in defining what is to constitute planning theory to begin with: "There is little agreement within planning as to what constitutes planning theory, as there is within feminism as to what constitutes feminist theory. […] Just as feminists use competing theories to understand or explain the oppression and subordination of women, planners use competing theories to explain the role, practice, and effects of planning" (ibid., p. 49). An important challenge for feminist approaches to planning theory is the tension between theorizations of gender that posit inequalities between men and women as central to critical social and political analysis and respective planning implications, and those that emphasize the diversity of gender relations, and see women and men as heterogeneous rather than homogeneous groups (Sandercock & Forsyth, 1992; Fainstein, 2005). Indeed, with the emphasis on multiple possible gender identities, but also the foregrounding of a variety of social variables that may entail discrimination, it has been noted that feminist efforts to further social justice have risked diluting intersectional inequalities between men and women to a rather vague discourse of acknowledging "diversity" in society (Rahder & Altilia, 2004). While symbolic representation, and recognition of diverse cultures and life-forms should not be neglected, Fainstein argues: "To the extent that left movements focus on issues of identity rather than economics and become diverted by symbolic causes, they do not provide the social force needed to create an economic context within which public policy can address their concerns. In a situation of extreme economic inequality, according privileges to the oppressed simply shuffles around who obtains higher positions in the economic hierarchy; it does not make those positions more broadly available. […] Planning, if it is to succeed in improving the lives of women, must have as its goal general improvement in the material situation of everyone who is relatively deprived at the same time as it delineates the particular needs of women" (Fainstein, 2005, pp. 133, 134; cf. Roberts, 2013; Sánchez de Madariaga & Neuman, 2016).

b) Cities of everyday life and the mobility of care

From the previous sections it should be clear that from the viewpoint of feminist planning theory, planning practice concerning gender and mobility should be a holistic endeavor, including procedural aspects as well as the definition of desirable goals. In terms of the latter, these relate to both visions for urban structures, as well as the re-valuation of different forms of travel, for example, as exemplified by the notions of the "city of everyday life" and the "mobility of care."

According to Greed (2008, p. 251), "as an alternative to spread out, zoned, low density cities," the former figures as important orientation for "many European women planners [who] would like to see the 'city of everyday life,' which they define as the city of short distances, mixed land uses and multiple centres as the ideal objective that would fully take into account gender considerations. Such a city structure would reduce the need to travel, create more sustainable cities that would be more accessible, whilst creating a higher quality urban environment for all.

It would provide more jobs and facilities locally and help revitalise declining areas overall (Skjerven, 1993).” With reference to efforts at creating more environmentally sustainable cities, this means also taking into account potential conflicts of interest (cf. Levy, 2013), e.g., when politically imposed restrictions on the use of private cars disproportionately affect women and poorer parts of the population. Hence, it is argued that “[r]ather than introducing negative carcontrolling policies first, it would be better to invest more in public transport and to use the planning control system to ensure that neighbourhoods are designed to provide local facilities, amenities and employment opportunities” as: “It is simply not realistic to carry home a week’s family shopping from the nearest, but distant supermarket, on the handlebars (or in the panniers) of a bicycle, particularly if one is working full time, is ‘time-poor,’ and cannot even guarantee to be at home if one subscribes to a home delivery service. If the full agenda of ‘sustainability’ were taken into account, rather than over-emphasising the environmental dimension, then it is likely that sustainable transport policy would prioritise different types of journeys as ‘essential,’ and more recognition would be given to the need for accessible public transport for all, whilst the routes and timetables would be reconfigured to meet the ‘off peak’ needs of women. A wider picture of travel patterns and their social value would be built up. Supporting services such as toilets, bus-shelters, creches, cycle lanes, steps, carriage of luggage, and shopping home delivery would all be integral components of the transportation infrastructure. Traffic control would be based upon the usefulness of the journey rather than the ability to pay” (Greed, 2008, pp. 251–252).

One way in which a “wider picture of travel patterns and their social value” can be developed is exemplified in Sánchez de Madariaga’s (2013a, 2013c) concept of the “mobility of care,” which is introduced as a methodological innovation, and also in terms of redefining which journeys are defined and “counted” as “essential” in travel research. The starting point for Sánchez de Madariaga’s critique is the way in which standard travel surveys systematically make invisible the amount of trips spent on care-related tasks, which frequently are hidden in categories such as “leisure,” “shopping,” or “escorting”: “Care work refers to the activities needed for the normal functioning of life, including the necessary tasks for the upkeep of the home and those required for the care of dependents, i.e. the sick, the young, and the old. These tasks may be realized in the home or in other facilities around the city, and they imply the use of transport systems. […] The mobility of care includes all travel resulting from home and caring responsibilities: escorting others; shopping for daily living, with the exclusion of leisure shopping; household maintenance, organization, and administrative errands, as opposed to personal walks for recreation; visits to take care of sick or elderly relatives that are, again, seen as different from leisure visits; and the like” (Sánchez de Madariaga, 2013a, pp. 52, 58). Such trips, however, are usually considered “non-compulsory travel,” which do not imply contractual obligations or financial compensation, but are therefore systematically undervalued as opposed to the notion of “compulsory or constrained travel” (such as commuting to places of work or study) (ibid., pp. 53–54). Thus, what is called for is recognition of such tasks and the complex trip-chains they involve (cf. Knoll & Schwaninger, 2020), which do not easily fit into prevailing priorities in transport planning for economic efficiency.

c) “Gender planning” and “gender mainstreaming”

“Gender planning” as an explicit concept was first conceived of in the context of developmental policy and practice during the 1980s, based on “the premise that women and gender were marginalised in planning theory and practice and therefore there was a need to develop gender planning as a planning discipline in its own right, with its own methodology” (Moser, 2014, p.

9). From a feminist viewpoint, to develop such a methodology and practice was deemed necessary for at least three reasons: First, a noted reluctance to engage with gender as an important category in planning practice, with most decision-making competencies "not only male dominated but also gender blind in orientation." Second, feminist scholarship itself had put strong emphasis on "highlight[ing] the complexities of gender divisions in specific socioeconomic contexts, rather than to show how such complexities can be simplified so that methodological tools may be developed enabling practitioners to translate gender awareness into practice." And finally, practitioners in planning practice itself felt it rather "difficult to 'graft' gender onto existing planning disciplines" (Moser, 1989, p. 1800). It is thus important to note that gender planning (as well as mainstreaming) approaches developed not only in opposition to prevailing, male-dominated planning discourses, but in part also in a tense relationship with more academic strands of feminist scholarship (cf. Roberts, 2013; Moser, 2014). While gender planning emerged as a distinct approach to urban development in the 1980s, gender mainstreaming was a later development, spurred by the 1995 Beijing Platform for Action, and the 1997 adoption of gender mainstreaming across all policy fields by the UN. With the 1998 Treaty of Amsterdam, gender mainstreaming also became a requirement in all areas of EUpolicy (Moser, 1989, 2014; Roberts, 2013; Sánchez de Madariaga & Neuman, 2016). While the 1980s and 1990s, according to Moser, can be called the "'golden age' of gender frameworks, and their associated training methodologies" (2014, p. 12), this was followed by a diffusion of related methodologies, and the partial integration of gender planning also in the "gender mainstreaming" agenda adopted by the UN in 1997.

While there have been critical voices cautioning against a "dumbing down" of gender mainstreaming, e.g., by substituting gender analysis for substantial involvement in planning processes; neglecting long-term transformational goals at the expense of short-term problemsolving; or the reduction of gender mainstreaming to the processing of bureaucratic checklists (cf. Moser, 2014), gender mainstreaming nevertheless provides an important reference in contemporary discourse on gender, transport/mobility, and planning (e.g., Roberts, 2013; Sánchez de Madariaga, 2013a, 2013b; Sánchez de Madariaga & Neuman, 2016). Gender planning and gender mainstreaming approaches have thus resulted in a wealth of practical guides and toolboxes designed to aid policy-makers and practitioners in incorporating gender issues in planning and decision-making. Related initiatives range from gender training programs, through gender analysis and audit frameworks, participatory planning processes, and design solutions, to public campaigns against violence against women and girls. The following list contains a number of respective guidelines, toolboxes, and further resources on "gender, mobility and planning" to provide background knowledge and practical guidance:

- Tovi Fenster's (2002) edited volume Gender, Planning and Human Rights collects a range of case studies from multi-cultural contexts that discuss and identify possibilities to integrate human rights issues in planning, development, and policy-making. Case studies stem from the UK, Israel, Canada, Singapore, the European Union, Australia, and the Czech Republic. Susan Fainstein and Lisa Servon's (2005) edited volume Gender and Planning: A Reader contains a variety of contributions dealing with both theoretical issues and areas of application. Topics covered are theorizations of public and private space, as well as feminist approaches to planning theory; and studies on the areas of housing, economic development, and transportation. Inés Sánchez de Madariaga and Marion Robert's (2013) edited volume Fair Shared Cities: The Impact of Gender Planning in Europe contains contributions on conceptual and practical aspects of gender planning and mainstreaming in urban contexts. Drawing on

experiences and empirical studies from cities across Europe, the volume also includes a number of concrete urban development projects and practical experiences regarding their implementation. Christina Scholten and Tanja Joelsson's (2019) edited volume Integrating Gender into Transport Planning: From One to Many Tracks contains contributions reflecting on feminist interventions in transport planning, ranging from conceptual and theoretical issues to empirical studies and the development of practical tools to improve transport planning from a gender perspective.

- Caroline Moser's (1993) Gender Planning and Development: Theory, Practice and Training provides a detailed account of the rationale and methodology of the "Moser framework" of gender training for planners and practitioners. This includes a detailed Appendix on the approach and structure of practical training courses. Developed in the context of developmental policy and practice, it has achieved a paradigmatic status in gender planning approaches. Caroline Moser's (2005) working paper An Introduction to Gender Audit Methodology: Its design and implementation in DFID Malawi, commissioned by the UK Department for International Development, provides the concept and methodology for a gender audit methodology, and relates it to practices of gender mainstreaming. It illustrates the components of a gender audit, its structure and content, and measurement issues.
- Carolyn Whitzman's (2008) The Handbook of Community Safety, Gender and Violence Prevention: Practical Planning Tools provides a comprehensive collection of international evidence on the effectiveness of intervention strategies to prevent crime, violence, and insecurity, drawing on case studies from initiatives around the world in urban and rural areas. Practical tools include ways to obtain diagnostic information on the prevalence and impacts of violence, the development and evaluation of effective policies and programs, and the creation of trust in partnerships. Anastasia LoukaitouSideris et al.'s (2009) report How to Ease Women's Fear of Transportation Environments: Case Studies and Best Practices published by the Mineta

  Transportation Institute contains the results of a comprehensive literature review and expert interviews on the perspectives and needs of women concerning safety in transit environments, an assessment whether these are met by transit agencies, and a discussion of model programs and best practice examples from cities around the world.

  The UN Women's (2019) Safe Cities and Safe Public Spaces for Women and Girls Global Flagship Initiative: International Compendium of Practices collects measures to address sexual harassment and violence against women in public spaces. Promising solutions from cities across the world involve addressing gaps in data, collaborative partnerships, laws and policies, inclusive urban and transport plans, and initiative to change social norms. The OECD's International Transport Forum's (ITF) (2018) publication Women's Safety and Security: A Public Transport Priority collected statements from its stakeholder on the importance of transport safety and security for women. The contributions argue for changes on different levels, from infrastructure and operational aspects, campaigns to further public awareness, the training of employees, reporting systems, data sources, women's employment in the transport sector, to new business models and the exchange of good practices among various relevant groups of stakeholders. Many of the brief statements provide weblinks for further information and resources. The Development Bank of Latin America and FIA Foundation's (2018) Ella Se Mueve Segura: A study on women's personal safety in public transport in three Latin American cities; Heather Allen, Marianne Vanderschuren, and University of Cape Town's (2016) Safe and Sound: International Research on Women's Personal Safety on Public Transport commissioned by the FIA Foundation; and the Asian Development

Bank's (2015) Policy Brief: A Safe Public Transportation Environment for Women and Girls provide research findings from both quantitative and qualitative research, recommendations for research methodologies and planning, and good practice examples on safety and security issues relating to women's use of public transport. Karla Domínguez González et al.'s (2015) Violence Against Women and Girls Resource Guide: Transport Brief contains further good practice guidelines and resources.

- Antonio Corral and Iñigo Isusi's (2007) report Innovative gender equality measures in the transport industry published by the European Foundation for the Improvement of Living and Working Conditions; Peter Turnbull's (2013) working paper Promoting the employment of women in the transport sector – obstacles and policy options published by the International Labour Office; and Jodi Godfrey and Robert Bertini's (2019) report Attracting and retaining women in the transportation industry published by the Mineta Transportation Institute provide examples of policy initiatives, empirical studies on barriers to women in the transportation industry, and recommendations to improve the situation of women workers in the transport sector. The International Transport Worker's Federation's (n. d.) Women Transporting the World: An ITF resource book for trade union negotiators in the transport sector provides guidelines, issue areas, and practical recommendations for negotiating good working conditions in the transport sector for women and men.
- The C40 Women4Climate initiative's (2019) report Gender inclusive climate action in cities: How women's leadership and expertise can shape sustainable and inclusive cities seeks to integrate issues of climate and gender in urban and transport planning, providing findings from empirical case studies, strategic tools, and further recommendations.
- Heather Allen's (2018) Approaches for Gender Responsive Urban Mobility – A Sourcebook for Policy-makers in Developing Cities, published by the German Corporation for International Cooperation and the Sustainable Urban Transport Project provides an overview of challenges to women's mobility, methods for assessing gender in urban transport, general directions for developing gender responsive solutions, a list and analysis of good practice examples designed to improve daily mobility of women, as well as steps and a checklist for implementation. The Institute for Transportation & Development Policy's (ITDP) (2018) Women and Children's Access to the City reports findings from qualitative research on everyday experiences and visions of a good life especially of vulnerable groups of women in Recife Metropolitan Area (Brazil). It provides recommendations and indicators for monitoring and evaluation addressing issues of transport infrastructure and safety, housing, and service provision.
- The African Development Bank Group's (2009) Checklist for Gender Mainstreaming in the Infrastructure Sector; The World Bank Group's (2010) Mainstreaming Gender in Road Transport: Operational Guidance for World Bank Staff; the European Bank for Reconstruction and Development's (2011) Urban rehabilitation and transport projects: Guidance Note; and the Asian Development Bank's (2013) Gender Tool Kit: Transport – Maximizing the Benefits of Improved Mobility for All provide recommendations on the implementation of gender mainstreaming in urban, transport, and infrastructure projects. The guides include templates and good practice examples for all stages of the project cycle.
- In the European Union context, the CIVITAS WIKI's (2014) policy note Gender equality and mobility: mind the gap! and Maria-Cristina Marolda and Ariane Dupont's (2014) She moves: Women's Issues in Transportation, commissioned by the European

Commission Directorate-General for Mobility and Transport, present empirical findings on gender inequality in transport in Europe, identify key areas of concern, and recommendations for policy and planning; the European Institute for Gender Equality's (EIGE) (2016) publication Gender in transport provides an overview of policy-relevant gender inequalities in transport, policy objectives at the EU and international levels, and a model for integration of gender issues in the policy cycle; Alejandro Ortega Hortelano and co-authors' (2019) report Women in European transport with a focus on research and innovation: an overview of women's issues in transport based on the Transport Research and Innovation Monitoring and Information System (TRIMIS) published by the EU's Joint Research Centre (JRC) provides a study on gender issues in transportation with a special focus on research and development, including an overview of exiting European initiatives and regulations, the evolution of research projects on gender issues, and women's participation in transport research and development, and policy recommendations.

- The City of Vienna's (2013) Manual of Gender Mainstreaming in Urban Planning and Urban Development contains the City of Vienna's approach to gender mainstreaming, often referred to as exemplary in international comparison. The manual comprises conceptual aspects of gender mainstreaming, gender-relevant objectives, requirements of user groups, and quality criteria, as well as exemplary projects, methods, and instruments, for different scales and areas of application. It includes considerations on planning objectives in two main thematic areas: urban structure, space creation, and housing quality; and public space and mobility.
- Useful Web-Links:
  - A gender audit methodology for public transport systems, including a broad literature review and the results of focus group discussions with women on their travel experiences, was prepared by Kerry Hamilton and Linda Jenkins (cf. Hamilton & Jenkins, 2000). It is now available on the homepage of the UK Department for Transport's homepage,[3] alongside further material related to "Women's transport issues."[4]
  - The webpage of the network Women Mobilize Women[5] launched by the Transformative Urban Mobility Initiative (TUMI) offers networking opportunities in efforts to improve transportation systems with regard to women's use of them, and provides information material and available best practice guidelines.
  - The Gendered Innovations webpage,[6] hosted by Stanford University, provides information material on gender dimensions in research and development processes in science, health, medicine, engineering, and the environment. Among a number of case studies[7] presenting concrete examples for the use of methods of sex and gender analysis in research and development, some deal specifically with topics related to "gender and mobility." These include "Information for Air Travelers,"

[3] https://webarchive.nationalarchives.gov.uk/20091203133541/http://www.dft.gov.uk/pgr/inclusion/women/ptgenderaudit (accessed: January 27, 2020)

[4] https://webarchive.nationalarchives.gov.uk/20091203102433/http://www.dft.gov.uk/pgr/inclusion/women/ (accessed: January 27, 2020)

[5] https://womenmobilize.org/ (accessed: January 27, 2020)

[6] http://genderedinnovations.stanford.edu/index.html

[7] http://genderedinnovations.stanford.edu/fix-the-knowledge.html (accessed: January 27, 2020)

"Pregnant Crash Test Dummies," "Housing and Neighborhood Design," and "Public Transportation."

- The webpage of the European Institute for Gender Equality (EIGE) provides information on a broad range of gender-related topics in the EU-context, including transport.[8] Beside best practice guidelines and overviews, information on relevant EU-policies and actions in member states can be found.[9]

Conclusion: main coordinates of feminist discourse on "gender and mobility," research desiderata, and outlook

Feminist discourse on gender and mobility has come a long way, developing over already roughly five decades. Starting from transport researchers' findings on the different travel patterns exhibited by men and women, and enriched by contributions from engaged feminist architects and planners, as well as feminist human geographers, the field has spawned an impressive amount of literature. Relating to feminist discourse more broadly, then, it is important to note the theoretical and programmatic shifts that have occurred over recent decades to understand corresponding developments in discussions on gender and mobility.

While "[t]he 1980s witnessed some flourishing of attention to gender in policy questions in the 'women and … ' literature" (Sandercock & Forsyth, 1992, p. 49), in feminist theory, "women's issues" were gradually less the focus of attention, and instead, increasingly more complex and contextualized analyses of gender relations, gender identities, and their intersection with other social markers of inequality such as class, race/ethnicity, age, and sexual orientation became of interest (cf. McDowell, 1993a, 1993b; McDowell & Sharp, 1999, pp. 104-109; Valentine, 2007). While earlier work tended to view "women" as a relatively homogeneous (and homogeneously oppressed) group, critics (particularly women of color, and queer people) began to question the validity of what seemed to be a rather ethnocentric and relatively privileged perspective on the oppression of women (i.e., one of mainly white, middle-class, heterosexual women). Rather than operating in broad structural categories, increasingly, the diversity among women (and among men) was scrutinized, to the point of questioning the centrality of "gender" as a useful analytical (and political) concept altogether, with a tendency to substitute a concern for the recognition of "difference" (between identities, groups, and cultures) for the more traditional liberal assumptions underlying a "language of (in)equality and rights" that united most of the work concerned with "gender and urban structure" (McDowell, 1993a, p. 168). This change in perspective corresponded with a broader methodological and theoretical shift in feminist research from "feminist empiricism" to a "standpoint/antirationalist" perspective, whereby "social relations – or in Harding's terms, the sociosexual division of labor" was the focus of the former, and "greater attention is given to gender symbolism, and to the construction of gendered identities" in the latter (ibid., p. 162; cf. Law, 1999; Bondi & Rose, 2003; Little, 2007). In this sense, feminist works in transport geography move closer to a model of "feminist empiricism" (cf. McDowell, 1993a), tending to posit "women" and "men" as rather homogeneous categories, whereas in human geography notions of difference and contextually specific gender relations and identities have increasingly come to dominate the discourse.

In attempts to systematize the diverse (feminist) contributions to discourse on "gender and mobility," commentators have thus noted that the field of research at large has developed

[8] https://eige.europa.eu/topics/transport (accessed: January 27, 2020)

[9] https://eige.europa.eu/gender-mainstreaming/policy-areas/transport (accessed: January 27, 2020)

roughly along two broad lines of inquiry, characterized by different research interests, preferred methodological approaches, relations to developments in feminist theory, and corresponding normative-political implications. Robin Law (1999), in her review of research on "gender and transport" identifies the fields of (feminist) transport geography/travel research and human/urban geography as major contributors, with rather distinct disciplinary make-ups. While the former is more closely related to the traditional, solution-oriented approach of transport research, more policy-oriented in the pursuit of research questions, and mainly characterized by the use of aggregate quantitative data on travel behavior; the latter, feminist human geography, has been more strongly linked to and influenced by developments in feminist theory, with a preference for qualitative methods and case study approaches, as opposed to studies in transport geography, which tend to abstract from local cultural and social specificities (cf. Law, 1999; Hanson, 2010; Joelsson & Scholten, 2019a). Drawing on Susan Hanson (2010), this bifurcation of the field finds a further parallel in the way scholars have addressed the relationship between "gender" and "mobility": on the one hand, researchers have been interested in "how movement shapes gender," and on the other, they have been concerned with "how gender shapes movement." That is, the former group has been interested in how the fact of being mobile or immobile, respectively, reinforces, shapes, or changes gendered power relations (e.g., restrictions put on the freedom of movement can lower access to social, cultural, and economic resources, thereby reinforcing a subordinate societal position – and vice versa); whereas the latter have put more effort in detailed analyses of movement patterns and travel behavior, with gender as the "independent variable" (e.g., the observation that women tend to exhibit more complicated travel behavior, have less access to cars, and therefore rely more on public transport systems). The two strands of research have thus tended to emphasize one side of the "gender-and-mobility relation" at the relative expense of the other (Hanson, 2010). At the same time, however, a shared tenet of mobility research has been the basic observation that, typically, "women's mobility is less than men's," which has, for the most part, been interpreted as an indicator of women's oppression, "as a negative, as evidence of lack of equal access to opportunity and in some sense evidence of women's subjugation" (ibid., p. 14).

While this conclusion may seem obvious, and in many cases may be convincingly argued, at the same time it contrasts calls for the contextualization of such observations. Thus, according to Hanson, the conclusion that "less mobility" can straightforwardly be equated with unjust power relations between the sexes or genders may in many cases have come about "because in most cases we have lacked knowledge of (1) whether any observed aspect of mobility or confinement in a particular social, cultural, or spatial context is the result of choice or constraint (which is often complicated and difficult to discern) and (2) what observed mobility patterns mean to people" (2010, p. 14). In other words, relying on quantitative information alone, it is often not possible to gain insight into the subjective experiences of and meanings attributed to mobility, or a lack thereof. To complicate matters further, on a global scale, "high mobility" in the "system of automobility" (Urry, 2004) may not be seen as a desirable goal for anyone, if one approaches the topic from a sustainability perspective: "It seems clear that if we are going to pursue sustainable mobility seriously, it does not make sense to posit the mobility patterns associated with masculinity as any kind of desirable benchmark with respect to personal mobility" (Hanson, 2010, p. 18). At the same time, observed differences in mobility patterns remain persistent, and have spurred ongoing research and debates.

There are also a number of research desiderata reported in the literature. To begin with, these are related to the ongoing need to further develop appropriate methodologies for enhancing

our understanding of the varying needs and experiences of different groups in diverse social, cultural, and geographical contexts (cf. Hanson, 2010). One approach to such research is the provision of appropriate data to allow for sufficiently nuanced analyses (cf. Sánchez de Madariaga, 2013a). Such data should not only be disaggregated according to sex, but also include sociocultural categories, such as age, class, race/ethnicity, disability status, life-cycle stage, and sexual orientation. Also, metrics to account for the degree of existing inequalities in mobility, as well as existing tools, such as audit methodologies and gender impact assessments, may be tailored to better fit particular geographical contexts (Loukaitou-Sideris, 2016). Beside these quantitative approaches, increased use of and integration with qualitative methodologies, as well as inter- and transdisciplinary research are argued for (e.g., Joelsson & Scholten, 2019a, 2019b). Furthermore, as most research in the field has tended to focus on the "journey-to-work-trip," conceptual developments (accompanying methodological and datarelated developments) for better capturing and understanding a range of trips associated with other daily activities, such as the "mobility of care" (Sánchez de Madariaga, 2013a, 2013c) or more general "geographies of everyday mobility" (Law, 1999), are called for (cf. LoukaitouSideris, 2016). Also, Joelsson and Scholten (2019b) argue that the very category of "gender" needs clearer operationalization to prove effective in policy-making and planning practice. In terms of empirical research objects, the geographical bias of most research on urban spaces in the Global North should be complemented by increased research efforts on both rural spaces, and spaces in the Global South, and new technologies, digital and mechanical (e.g., highspeed trains or smartphones), should also prompt new research questions regarding the opportunities and possible downsides they may entail. Again, geographical contexts play an important role, as new technologies may be more readily available in cities of the Global North than in other regions of the world. Also, idealizations of new "technological fixes," such as the use of CCTV technologies to create safer public spaces, should be treated in a differentiated manner, as their employment may fail to deliver on the desired results (cf. Loukaitou-Sideris, 2016). Finally, means for proper presentation and communication of information to foster inclusive, democratic, and transparent processes in planning and policy-making are advocated (Joelsson & Scholten, 2019b; cf. Sánchez de Madariaga, 2013a).

As should be evident from the literature on gender planning and the considerable amount of best practice guidelines pointed to in the preceding section, there are a number of concepts and methodologies available to cater to the various gender issues at stake in the design of (urban) community spaces and traffic systems. At the same time, it has been noted that gender issues in transportation still often face difficulties in being recognized as a priority among policy-makers (Loukaitou-Sideris, 2016). In this context, the promotion of "gender mainstreaming" by the Beijing Platform for Action, which was adopted also in the Treaty of Amsterdam, is seen by many as the most promising lever for further implementing genderrelated transport and urban design policies (e.g., Roberts, 2013; Sánchez de Madariaga, 2013a, 2013b; Loukaitou-Sideris, 2016; Sánchez de Madariaga & Neuman, 2016). At the same time, "gender mainstreaming" remains a disputed concept, and even more so among feminist scholars themselves. As Caroline Moser (2014, p. 14) notes with reference to the career of gender planning and mainstreaming approaches, the feminist project of integrating theory and practice always had to deal with a tension "between academics' critique and practitioners' positivism. While academia is more grounded in the analytical critique 'of what's wrong,' the mandate of practitioners is to implement 'what's right,' requiring policies to ensure virtuous rather than vicious cycles." Correspondingly, a number of scholars have argued for the continued relevance of the category "gender" as not only one among many, but the most relevant marker of social inequality – and against diluting "gender" into merely one category among others in a

vague “diversity” discourse (cf. Rahder & Altilia, 2004; Fainstein, 2005; Roberts, 2013; Sánchez de Madariaga & Neuman, 2016).

Arguments have furthermore asserted, in a similar vein, that many of the practical implications that could be associated with gender planning and gender mainstreaming approaches to urban and community design (such as alleviating over-reliance on private cars, strengthening public transport, facilitation of care trips, and relevant measures to be taken in the physical environment) do more than just support women as the main beneficiaries. There also exist strong synergies with concepts of “barrier free” environments and “universal design” suggesting improvements for both women and men who take on care-related tasks in the home, for friends, family, and the broader community, as well as for children, elderly, and persons with disabilities who may benefit from safer and more easily accessible spaces (cf. Loukaitou-Sideris, 2016). From this perspective, especially the notion of “care,” or “reproductive labor,” the provision of necessary resources for which to sustain social relations, order, and peoples’ wellbeing targeted by many feminist planning approaches, appears not as a luxury, but as a fundamental pillar of society: “Comprising both affective and material labour, and often performed without pay, it is indispensable to society. Without it there could be no culture, no economy, no political organization. No society that systematically undermines social reproduction can endure for long” (Fraser, 2016, p. 99).

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Review

A Review of Energy and Gender Research in the Global North

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Contents

Gender Issues in Energy

Introduction

To date, the relationship between gender, and energy use and planning has predominantly been seen as a topic of interest in the context of the global South. In non-industrialised nations, energy use is strongly linked to hard, physical labour, health risks, and an extreme absorption of women's time; issues which are not so pertinent in a Northern industrialised context. (Cecelski, 2004) For this reason, there was a general assumption that was no 'Northern perspective' (Carlsson-Kanyama & Lindén, 2007 pp. 2163) on the subject, and that energy in the context of the global North was essentially value-neutral. This has been increasingly challenged over the last twenty years, a challenge that has, in many ways, been prompted by the emergence of the 'low-carbon transition' or 'energy transition' on the global political landscape. Two main research agendas become apparent upon review of the literature concerning energy and gender. The first is strongly grounded in the growing drive to reduce energy consumption, and to achieve the 'energy transition,' and is concerned with how gendered analysis can contribute to the achievement of particular goals, whether this is reducing peak load on the grid or facilitating the transition to 'low-carbon' futures. The second strand instead turns to questions of gender equality, and a number of the questions addressed by this body of research are asked in the early analytical framework outlined by Clancy and Roehr:

> 'Are the lives of women and men affected differently in terms of the energy forms they use? If gender differences towards energy exist, are women and men able to exercise choices that reflect those differences about energy? Do women and men in the North have different preferences for energy policy? Are women able to make effective contributions as academics, as activists and as workers in the energy sector?' (2003, pp.17)

These authors question the assumption that men and women in the global North have the same relationship to energy as it is now, and argue that these differences can be further increased as energy systems change. In cases where research is contextualised by the 'energy transition,' distinctly different issues come to the forefront: the 'energy transition' may still be presented as a desirable goal but it is looked at as a matter of social justice, a theme that has gained increasing importance with the recognition that energy transitions are accompanied by huge underlying social upheavals. (Miller, Iles & Jones, 2013) Gender equality demands that men and women have equal access to services and goods that have value in society, and that they have equal power to determine the shape of their own lives. In the case of the energy transition, this also means ensuring that the benefits and burdens of the change are not distributed unevenly. (Clancy & Roehr, 2003)

The literature concerning energy and gender in the Northern industrialised context is still sparse, and is theoretically divided in some important ways. This review will first discuss the different theoretical approaches to gender that emerge in the literature and outline the standpoint of this review. The main body of the review will address the two key branches of literature that have been identified in this introduction: gender and its investigation as a factor for the success or failure of energy interventions, and energy and gender equality, discussing

how they are in conversation. Finally, this review concludes by summarising the current state of the literature on energy and gender in the global North, and touches on literature in the global South to highlight some potentially problematic elements of the Northern body of gender and energy literature.

Conceptualisations of Gender

In the energy literature there has begun to be some departure from the construction of individuals as rational economic actors, whose choices and practices with regard to energy are purely shaped by economic considerations. Instead, an individual's relationship to energy is seen as emerging as a product of their material constraints, preferences, values, and the norms that are attributed to them according to certain socially constructed identities. This has opened up energy research to gender analyses and it is worth discussing the different theoretical approaches to gender that are used in the energy literature. (Anfinsen & Heidenreich, 2017; Bell et al., 2015; Carlsson-Kanyama & Röhr, 2010; Cecelski, 2004; Clancy & Roehr, 2003; Dunphy, Revez, Gaffney, & Lennon, 2018; Dunphy, Revez, Gaffney, Lennon, & Aguilo et al., 2018; Elnakat, Gomez & Booth, 2016; European Commission, 2014; European Institute for Gender Equality, 2012; Elnakat & Gomez, 2015; Fraune, 2015; Fraune, 2016; Fraune, 2018; Heinzle, Känzig, Nentwich, & Offenberger, 2010; Henwood & Pidgeon, 2015; Khamati-Njenga & Clancy, 2003; Magnusdottir & Kronsell, 2014; Offenberger & Nentwich, 2010; Prietl, 2017; Ryan, 2014; Standal et al., 2018; Tjørring, 2016; Tjørring, Jensen, Hansen & Andersen, 2018; Wesser, 2012)

A large portion of the literature leaves gender un-theorised. This leaves implicit its understandings of gender and therefore any underlying assumptions that are being made regarding gender. This is particularly true of the quantitative literature that uses gender as an analytical category. The vast majority of the remaining literature views gender as socially constructed and rejects the conceptualisation of gender norms as biological or intrinsic 'truths.' A number of authors further deploy conceptualisations of gender as 'relational,' which acts to further break down the essentialization of gender. Conceptualising gender as 'relational' further emphasises the fact that 'male' and 'female', or the 'masculine' and the 'feminine' are only constituted with reference to each other, and have no independent meaning. The distribution of traits and capacities across this constructed binary, and the strictness of the separation between them are highly variable across time, and across cultures. Therefore, the actual meaning of what it is to be a 'man' and what it means to be a 'woman' is intrinsically unfixed, and unstable. (Flax, 1987) Analysing gender relations instead of gender roles can enrich analyses as this approach focuses on the connections between men and women's lives, and the power relations that exist between them. (Khamati-Njenga & Clancy, 2015) Presenting gender as relational is also seen as a way to incorporate the multiplicity of individual experience, as it acknowledges that each individual's experience of gender relations is shaped by other social relations like class and race.

(Flax, 1987) Acknowledging the heterogeneity of gender in this way has also prompted a new, and small body of work that uses intersectionality as a methodology. Intersectionality further argues that the interacting effects of various sociodemographic factors means that one cannot be analysed separately from the others. Furthermore, the overlap of different power relations according to these factors can have a compounding effect on the experience of multiple interlocking forms of marginalisation.

The different approaches used in the various studies discussed here won't be addressed extensively throughout the body of the review; however, it is the perspective of this review that the results discussed here should be approached from a constructivist perspective on gender. The particular constructions of gender roles and gender relations can be stabilised over an extended period of time so are a worthy topic of analysis; however, any findings should not be taken to communicate something intrinsic and immutable about the characteristics of a particular gender. In this understanding, gender is something we do not something we are and is something that can be both done and undone.

Gender and Energy Interventions

How to achieve successful energy interventions has become an important question, as the need to 'decarbonise' our energy systems has become more and more urgent. This means phasing out fossil fuels and integrating other energy sources, like renewables or nuclear power. Moreover, the energy transition will likely demand changes in people's energy practices, not only in terms of absolute consumption but in terms of what types of consumption will be deemed more or less acceptable. (Fraune, 2018) What form the energy transition will take is by no means set in stone, but will inevitably require substantial efforts to gain public acceptance and behavioural changes. Assessing public attitudes towards particular energy interventions, and their willingness to change their behaviour has therefore become an important subject of analysis in service of successful energy interventions, as has the analysis of energy practices. Understanding energy practices, and the factors that lead to their obduracy, is seen as a means to shape the transition in such a way as to overcome the factors that limit the ability or willingness of individuals to change their energy practices. This can be through behaviour change, energy efficiency upgrades or the adoption of new technologies. In this body of literature, gender has largely been taken as a category of analysis to more successfully target energy interventions according to the attitudes, practices and obduracies of particular demographics; in particular, gender is seen as a key factor when looking at household energy consumption.

Analyzing Attitudes: Technologies and Behavior Change

Research in this area looks at attitudes towards different energy technologies, including energy sources: fossil fuels, renewables, and nuclear; as well as technologies like smart meters that are being integrated into the energy infrastructure. Attitudes toward changing energy-related behavior is also an important, and often intertwined element. The methodological approach in this area is predominantly quantitative, which has its own strengths and is important for identifying broad trends; however, there has been some critique of the relative lack of qualitative research, which is argued to have greater explanatory strength for exploring the reasons behind gender differences. (Fraune, 2016; Henwood & Pidgeon, 2015)

Attitudes Towards Technologies and their Adoption

There is some evidence that there are differences in attitudes towards different energy supply technologies between men and women; however, the evidence is equivocal in the majority of cases. The strongest evidence exists for gender differences in attitudes towards nuclear power, while for other technologies evidence is newly emerging or somewhat ambiguous. Women have consistently been shown to be less supportive of nuclear power than men, while

the size of the gap varies, this is a trend that has proven to be robust over time, country and independently of other demographic factors. (eg. Dunphy, Revez, Gaffney, & Lennon, 2018; Gutschik & Sturm, 2012; Henwood & Pidgeon, 2015; Jäckle & Bauschke, 2011; Pampel, 2011; Solomon et al., 1989; Sundström & McCright, 2016; Visschers & Siegrist, 2014) This difference has been found to persist at the level of policy-makers in Sweden, (Sundström & McCright, 2016) and in other work that looked at five Nordic countries: Denmark, Finland, Iceland, Norway, and Sweden. (Jensen, 2000) However, these studies also found that this difference disappeared when controlling for party affiliation. For example, Jensen found that this difference persisted only in 'social democratic women,' and for this reason they found greater explanatory power in party ideology. (2000, pp.391) While the authors normalised for party affiliation, it is worth noting that other authors have found significant differences in the distribution of gender across different political parties. Gender differences in party affiliation can't automatically be attributed to gendered differences in ideology because other factors; for example, systems of women's recruitment will play a role. Nevertheless, this factor would benefit from further scrutiny. (Fraune, 2016)

Analysis of attitudes to other technologies is largely emerging, underdeveloped or contradictory. The reasons behind contradictory results are difficult to assess as the questions asked about the same technologies are varied in nature so may produce different results. In addition, these studies vary in terms of their scope, historical and cultural context and approach, which can each have their own effects. Hydraulic fracturing (fracking) has recently emerged as an energy source of interest, and there's some evidence different levels of support between men and women. Women are less likely to support fracking for shale gas and oil, and are more likely to think of it as an environmental risk than an economic opportunity. (Davis & Fisk, 2014; Thomas et al., 2017) There is also some evidence that they are less likely to support gas with carbon capture and storage (CCS). (Karlstrøm, & Ryghaug, 2014) In terms of attitudes towards mainstream fossil fuels, and renewable energies, findings are contradictory. Longstreth, Turner, Topliff & Iams (1989) found that women in the US were less likely to support fossil fuel energy paths, and that they were more or less supportive of renewable energies according to whether a univariate or multivariate analysis was applied. In contrast, Greenberg (2009) found that women were more supportive of both fossil fuels, and of renewable energies. Balta-Ozkan & Le Gallo (2018) also found greater support for fossil fuels amongst women; however, they were more likely to see renewable energies as the most important for the future, as well as seeing environmental protection as a key goal for both energy policy, and national policy overall. Other studies reported no significant difference in acceptance of renewables, (Dunphy, Revez, Gaffney, & Lennon, 2018; European Commission, 2003; Sardianou & Genoudi, 2013) and Dunphy, Revez, Gaffney, & Lennon (2018) found that fossil fuels ranked uniformly poorly in the energy preferences in both men and women, though there was slightly more variation in women's preferences.

When it comes to preferences for individual forms of renewable energies, results are similarly contradictory. There is some indication that women are less supportive of hydroelectric power (Balta-Ozkan & Le Gallo, 2018; Karlstrøm, & Ryghaug, 2014; Visschers & Siegrist, 2014) but are more likely to have positive views towards bioenergy, (Karlstrøm, & Ryghaug, 2014) and solar power. (Sütterlin & Siegrist, 2017; Visschers & Siegrist, 2014) Despite reportedly having more positive views of solar power, there is some evidence that women are less likely to report intentions to install solar panels (Petrovich, 2018) or an intention to generate their own energy generally. (Leenheer, de Nooij & Sheikh, 2011) However, still other studies find that gender is not a significant factor. (Sardianou & Genoudi, 2013) Findings regarding offshore and onshore wind energy vary, with some reporting equal support for wind power. (Dunphy,

Revez, Gaffney, & Lennon, 2018; Ek, 2005; Firestone & Kempton, 2007; Karlstrøm, & Ryghaug, 2014) Others find lower support among women, (Klick & Smith, 2010; TNS, 2003) and in some cases, lower support is found despite finding higher support for renewables amongst women overall. (TNS, 2003) Still others find that women are more supportive of wind power (Devine-Wright, 2007; Visschers & Siegrist, 2014) but prefer smaller installations to men. (Krohn & Damborg, 1999)

The research discussed above has largely been quantitative in nature, and while gender has been included as a singular category of identity, it has rarely been taken as the focus of studies and has generally not been meaningfully analysed. Overall, the very variation within study findings implies that more research needs to be done in this area, that not only seeks to bring clarity to the gender effects on attitudes, but also seeks to explain why these differences might exist and under what circumstances.

To date, and perhaps unsurprisingly, gendered differences in attitude to nuclear power are the only ones that have received real attempts at explanation. This can perhaps be explained by the fact that nuclear power is the only energy source that shows a clear and consistent difference in attitudes by gender. This difference is attributed to women having a higher perception of risk and concern for the environment, as women generally report greater concern for environmental and health risks that are posed by nuclear energy. Work that has attempted to more deeply engage with, and explain why women may perceive greater risk is dominated by quantitative survey methods that attempt to make judgements about underlying psychological or socio psychological causes. This literature has attracted criticism as being undertheorized and lacking real empirical support, and there are calls to engage with a number of further research avenues. (Henwood & Pidgeon, 2015; Wesser, 2012) These include analysing how cultural context can shape perceptions of risk in light of studies that non-white males expressed perceptions of nuclear risk that were much more in line with those of women. White males were found to contribute most of the difference in gendered perceptions of risk, something which has been termed the 'white male effect.' It has also been argued that it must be recognised that men and women do differ in terms of their vulnerabilities to types of risks, their ability to make decisions regarding risk, and have very different experiences in the aftermath of any form of disaster. It is proposed that this very practical difference between men and women can have important implications for how risk is perceived, and could represent an important way of meaningfully engaging with gendered perception of risk. (Wesser, 2012) Finally, it has been proposed that engaging qualitatively with the discursive construction of risk is important to understand how this is performed, and is potentially gendered in context. (Henwood & Pidgeon, 2015).

It has been argued that gender is by no means a homogeneous category, and doesn't act to define an individual's attitudes or practices in isolation of other attributes: factors like socioeconomic status, sexual orientation and race come with their own privileges or inequalities, which interact with each other and are not easily separable. (Clancy & Roehr, 2003; Collins, 1999; Crenshaw, 1989) The intersection of these characteristics has received some attention in the energy literature, and there is evidence that attitudes towards different energy source can also be highly varied within gender categories, with characteristics like education and race having a strong role to play. (Greenberg, 2009) Dunphy, Revez, Gaffney, & Lennon (2018) aimed to gain clarity on how these different types of characteristics produced attitudes towards energy by conducting a qualitative intersectional analysis of people's attitudes to the energy system in six different communities. They interviewed men and women

in communities in Spain, the UK, Ireland, Italy and France, to produce an analysis that took into account age, gender, and socioeconomic status. In their intersectional analysis, Dunphy, Revez, Gaffney, & Lennon (2018) argued that an individual is not defined by a single characteristic, and that understanding attitudes means conceptualising them as emerging from a complex interplay of multiple intersecting characteristics, and their interactions with wider social norms, institutions, and structures.

The authors found that, largely, attitudes towards renewables were uniformly positive across men and women, with any significant differences in attitudes emerging between the six communities, rather than within. The authors see this as indicative that the broader experiences and contexts of the communities themselves were the significant factors, rather than any gendered experiences. For example, a lack of agency and democratic process with regards to renewable installations was mentioned as a distinct negative, and was thought to result in more unfavourable attitudes in communities that had had them forced on them in the past. In terms of attitudes towards non-renewables and nuclear power, women demonstrated a slightly greater variation in attitudes towards fossil fuel sources than men, who showed a more uniformly strong dislike. In contrast, men were more likely to support state investment in nuclear power in comparison to women, with 5% of men and only 1% of women in favor; numbers which reflect trends reported in previous research. However, the attitudes of men and women were more similar than different: while there were some variations, support for both fossil fuel sources and nuclear were overwhelmingly negative across both genders. (Dunphy, Revez, Gaffney, & Lennon, 2018)

Attitudes Towards Changing Energy Behaviours

Attitudes towards technologies and towards behaviour change often go hand-in-hand in the context of energy, and this interdependence can be left somewhat implicit. Reducing energy consumption, and increasing demand flexibility are often presented as important goals in the energy literature. Renewable energy sources have intrinsically less controllable energy production rates and demand flexibility is seen as necessary for their incorporation into largescale energy grids. It therefore argued that increasing demand flexibility is important for both achieving the ‘energy transition’ and for decreasing peak demand to increase grid stability and security. ‘Smart meters’ and the accompanying ‘smart grid’ have been promoted in recent years as a means by which energy companies can successfully achieve these goals. Largely, this belief relies on the hypothesis that introducing ‘real time pricing’ will lead to load shifting, as using electricity at peak times will be more expensive. (Brodberg & Persson, 2015; Tjørring, Jensen, Hansen & Andersen, 2018)

There is some evidence of gendered differences in reported willingness to change energy behaviours. Women assign higher importance to reducing energy consumption in comparison to technological advancements, (Balta-Ozkan & Le Gallo, 2018; Röhr & Hemmati, 2008) and are more likely to state that they would change their practices in response to an increase in energy prices. (Carlsson-Kanyama & Lindén, 2007; Lee, Park & Han, 2013; European Institute for Gender Equality, 2012) Despite this price sensitivity, women are also more likely to express willingness to change to a green supplier of energy, despite higher pricing. (Empacher, Hayn, Schubert, & Schultz, 2001; European Institute for Gender Equality, 2012) Gender has also been used as an analytical category when investigating consumer willingness to adopt direct load control (DLC), whereby energy companies control a consumer’s use of power directly. This is seen as an attractive means to circumvent the consumer and directly influence power demand. Generally gender was not found to be a significant factor, apart from women

expressing more discomfort with having their energy consumption externally controlled during morning peak hours. The authors attribute this to women doing a larger proportion of household labour; however, this was not meaningfully explored. (Brodberg & Persson, 2015) Differences in attitudes are no guarantee of differences in behaviour; nevertheless, this is an avenue worth investigating if only to begin to elucidate the reasons for any disparities between attitudes and behaviours. (Heinzle, Känzig, Nentwich & Offenberger, 2010)

Energy Practices: Gender and the Household

Previous research has found that there can be huge variations in energy consumption between families that are demographically similar, despite also living in similar homes. Studies have reported that the highest consuming households can be using anywhere up to ten times as much energy as their low-consuming counterparts, (Firth, Lomas, Wright & Wall., 2008) a large proportion of which, can be explained by the behaviour of the occupants. (Gill, Tierney, Pegg, & Allan, 2010) There has also been some concern expressed that the development and adoption of new technologies may prove to be insufficient to achieve the 'energy transition.' Increasing energy efficiency or incorporating renewable energies generally achieve lower reductions in overall consumption than predicted, due to households changing their energy behaviours. There is also a concern that increasing demand will mean that any reduction achieved by these technologies is eventually erased. (Aydin, Kok & Brounen, 2017) These two factors have prompted an increased interest, in both the policy and research spheres, in understanding individual's energy practices, so that interventions for changing these behaviours may be better targeted. The focus on targeting interventions for reducing energy consumption, and changing consumption patterns in the home made gender a category of interest in this field of research. To date, the majority of the somewhat sparse research into the differences in energy practices by gender has focused on the household arena, with some attention paid to other arenas such as transport, and indirect forms of energy consumption.

Gender and Energy Consumption

There are few studies that seek to analyse how individual or household levels of energy consumption might be influenced by gender. These studies also very according to what types of energy consumption are included. In their analysis of direct and indirect energy consumption, Räty and Carlsson-Kanyama (2009) found that the average single man consumed more energy than the average single woman. In terms of direct energy consumption, recent findings in the US have found that female dominated, or female 'headed' households consume more energy, and particularly gas, per capita than their male dominated, and male 'headed' counterparts. (Elnakat & Gomez, 2015) Female-dominated ZIP code have also been found to have higher rates of energy consumption, shifting the focus from the somewhat poorly defined social figure of 'head of household' to a more individual figure. (Elnakat, Gomez & Booth, 2016) The authors invoke a number of possible explanations for this, including that female-headed households tend to occupy older houses, perform more energy-consuming activity to do with cleanliness, or prefer a higher thermal setting. Another potential factor mentioned was the greater amount of time spent in the home by women, particularly by older women who make up a higher proportion of the population than older men. (Elnakat & Gomez, 2015; Elnakat, Gomez & Booth, 2016) In addition, evidence emerged that household composition according to gender and employment status can affect energy consumption within the household, with two income households consuming more energy than

both ‘stay-at-home’ females and single, working females. The suggested explanation for this disparity invoked the gendered division of household labour, arguing that the higher energy consumption found in two income families is attributable to women juggling work, and household responsibilities, which means carrying out tasks which are often geographically dispersed. (Clancy & Roehr, 2003) These studies give further weight to the importance of analysing the interactions between gender and energy, and performing deeper analyses of the reasons behind any differences that emerge.

Gender and Household Energy Practices

The studies on gender and energy practices within the household that have been conducted to date, have focused on the traditional ‘nuclear’ family and there is little data to be found on other

household arrangements. Studies on ‘nuclear’ households have found that household labour is still strongly divided according to traditional gender roles, with women undertaking the majority of the cooking, cleaning and laundry. This means that women use the most energy intensive appliances and perform the tasks within the household that are responsible for the largest proportion of energy consumption. (Bell et al., 2015; Dunphy, Revez, Gaffney, Lennon, & Aguilo et al., 2018; Ellegård & Palm, 2015; Standal et al., 2018; Tjørring, Jensen, Hansen & Andersen, 2018) Men are instead responsible for the maintenance of the home and the home energy consumption that is attributed to them is consumed through use of the TV or the computer. (Bell et al., 2015; Carlsson-Kanyama & Lindén, 2007; Dunphy, Revez, Gaffney, Lennon, & Aguilo et al., 2018; Ellegård & Palm, 2015; Tjørring, 2016; Tjørring, Jensen, Hansen & Andersen, 2018)

Dunphy, Revez, Gaffney, Lennon, and Aguilo et al., (2018) also found gendered differences in energy practices with regards to, what they termed, ‘creating home.’ They found that in their qualitative interviews, women were much more likely to talk about energy use in terms comfort that they supply to other people, whether through heating or ambient lighting. For example, one mother reported warming up her child’s pyjamas in the dryer, and a grandmother always kept her house warmer when her grandchildren were visiting. This need or desire to create a comfortable home, often for the sake of others, meant that it was deemed acceptable to consume energy for this purpose even to individuals who were very conscientious about their energy use in other areas.

Such strong differences in time spent on particular domestic tasks, particularly cooking, are not apparent in single adult households. (Dunphy, Revez, Gaffney, Lennon, and Aguilo et al., 2018) However, Clancy and Roehr (2007) found that single men and women tended to own different types of appliances, and that therefore there is some indication that they may have different energy practices. (Clancy & Roehr, 2003) Currently, studies on non-nuclear households are all but non-existent; however, gaining greater insight into the gender differences in energy practices of different types of households is likely to become more important as the number of these types of households grow. (Fokkema & Liefbroer, 2008) Gendered energy practices within households are frequently treated as entirely independent of each other, and the household treated as a ‘black box.’ However, there are a number of authors who point to the importance of considering household dynamics for meaningfully developing policy interventions. (Bell et al., 2015; Tjørring, Jensen, Hansen & Andersen, 2018)

The utility of this approach has been argued for in light of findings that the attitudes of both the male and female partner more accurately explain household energy use behaviours than those of a male or female only. (Yang, Shipworth, & Huebner, 2015)

Bell et al., (2015) take this approach in their study, and argue that it is the social dynamics within and across households that are key to understanding energy practices. In their analysis, energy practices emerge as a result of household member's positioning to, and interactions with each other, as well as their material surroundings and socio-economic factors. The dynamics within the household are then informed by and connected to wider social and economic systems. They see

this type of analyses as important for informing policies and techniques that will achieve a reduction of household energy consumption by moving away from a focus on technical methods and towards responding to socio-cultural practices that exist both within and across households.

In their analysis Bell et al., (2015) found that division of labour occurred according to traditional gender roles in 61 of the 131 households visited, noting; however, that this could be a cultural relic of the history of heavy industry and mining in the North of England, where the data was gathered. Women were largely responsible for cooking and washing, while men engaged in practices like mowing the lawn or DIY. While labour was commonly divided in this way, the authors argue that this does not necessarily represent a facile means of targeting interventions, and precipitating a shift of energy consumption patterns. Instead the timing and amount of energy consumption is highly contingent upon other members of the household, who may, or may not be in continuous residence, as is the case with adult children who return to the parental home. Therefore, energy practices are not defined wholey according to the individual who is responsible for the labour, but the needs and practices of other members of the household, and how household members construct their responsibility to, and accommodate each other. This is reflected in the 'home making' practices of women that were discussed by Dunphy, Revez, Gaffney, Lennon, and Aguilo et al., (2018). It is not just a case of asking who is switching on the appliance, but of asking who they are doing it for and why. The 'why' can be seen as highly symbolic in nature and as intimately linked to the construction of individual identities, which is perhaps reflected in their highly gendered nature. Heating the home, doing laundry, and maintaining personal cleanliness become the means by which individuals build their identities as 'good' grandmothers, mothers, fathers etc. (Dunphy, Revez, Gaffney, Lennon, & Aguilo et al., 2018) Engaging with this 'messiness' is necessary for producing effective energy interventions for reducing peak demand, and achieving wider environmental goals (Bell et al., 2015)

Gender and Changing Household Energy Practices

Ultimately, the research into energy practices has generally been conducted with the aim to change these practices, and there is some evidence that women more frequently change their energy behaviours in response to various energy interventions. Women with smart meters installed in their homes were found to check their in home displays more frequently than men, and were more likely to encourage friends and family to change their energy practices. (Clancy & Roehr, 2003; Department of Energy & Climate Change, 2013) They were also more likely to engage in neighbourhood 'Eco-Teams,' which met periodically to discuss ways of reducing

consumption. (Carlsson-Kanyama & Lindén, 2007) In addition, Tjørring, Jensen, Hansen and Andersen (2018) found that reminders to shift energy consumption to certain times of day were much more likely to achieve an actual change in behaviour when sent to women. This was thought to be attributable to gendered divisions of labour in the home: sending the text to the person responsible for a task is generally more effective than reminding someone who is not. Tjørring (2016) also found that 'energy reminders' in the form of smart meter displays had the potential to cause conflict in the household in cases where the individual monitoring energy consumption and making demands for energy reduction was not the one engaging in the energy practice. There is also some indication that women are willing to engage in energysaving behaviours, despite them leading to increased personal discomfort and workload. (Carlsson-Kanyama & Lindén, 2007)

Women therefore appear to be the most responsible for changing energy behaviours within the home, and encouraging others to do so. However, men are predominantly responsible for reducing energy consumption through energy efficiency measures like investing in thermal insulation, boilers and hot water installations. (Clancy & Roehr, 2003) This is consistent with findings that men generally identify themselves as responsible for the renovation and maintenance work round the home, and the grounds in which it is situated. (Bell et al., 2015; Carlsson-Kanyama & Lindén, 2007; Dunphy, Revez, Gaffney, Lennon, & Aguilo et al., 2018; Ellegård & Palm, 2015; Tjørring, 2016; Tjørring, Jensen, Hansen & Andersen, 2018) This division has also been found to extend to home upgrades that involve renewable energy systems like solar panels, (Henning, 2005; Standal et al., 2018) and sustainable home heating systems. (Offenberger & Nentwich, 2009) Household dynamics remain an important area of analysis when looking at changing practices in the household as both behaviour changes and home renovations occur as a process of negotiation, and joint decision-making. (Henning, 2005; Offenberger & Nentwich, 2009; Standal et al., 2018) Decisions are made according to the needs, priorities, and values of the different members of the household. However, decision making power is gendered and who has greater decision making power is highly influenced by who's area of responsibility the change to be made falls into, and to what space alterations are to be made. (Henning, 2004; Standal et al., 2018; Tjørring, 2016) In their study of prosumers across several European countries, Standal et al., (2018) found that these types of gender roles and relations within the household had implications for the uptake of home solar systems. Men were generally the driving force behind the adoption of the system, and were more likely to check and keep notes of energy production. The smaller number of women that were the driving force behind solar panel installation were generally employed in the energy industry and also monitored energy production. Henning (2005) reported similar findings with regard to gender differences in engagement with solar systems, but instead reported that women who wanted to install solar systems tended to act indirectly through their husbands.

Standal et al., (2018) probed this divide by interviewing the individual prosumers. In the interviews, all parties stated that gender was irrelevant to becoming a prosumer, and while prosumers were more commonly described as male, respondents advocated for the competency of both genders when asked directly. Generally, interviewed prosumers painted the gender divide as a matter of personal interest: men were more interested in technology, and it was imagined that they would engage with solar power as a result of financial, technical or environmental motivations. In contrast, women's imagined interests were generally confined to the environmental. However, the degree to which motivations and interest were attributed differently according to gender varied across the different countries investigated: gendered imaginations of prosumers as men were most apparent in the Ukraine, while interviewees in the UK stood out as particularly avoiding, and even actively resisting dividing motivations and

interest by gender. While interest in the technology was not really stated by women to be an important motivation for them, imagined interests and motivations were not necessarily in line with the actual reasons given for engaging in prosuming. Financial reasons were often given by women, which was at odds to how their motivations were often imagined, and this motivation was in some cases stated more often by women than by men. (Standal et al., 2018)

This kind of classification of certain objects as 'technical' and therefore as 'masculine' is conceptualised as a form of 'gender script' in other work on energy and gender. (Heinzle, Känzig, Nentwich, Offenberger, 2010; Henning, 2004; Offenberger & Nentwich, 2009; Prietl, 2017) In this context, the concept of 'gender scripts' centres around the idea that objects, preferences or interests are coded as being intrinsically the purview of the 'masculine' domain. It then becomes inappropriate, inauthentic or simply odd for women to engage with these objects or express certain preferences and interests. Important examples that have been highlighted in this field include 'hard' energy paths (fossil fuels, nuclear, masculine) and 'soft' energy paths (renewable, feminine); economic or technical (masculine) and environmental (feminine); technical (masculine) and non-technical (feminine). It is argued that kitchen appliances are no less 'technical' than solar panels; however, they are not defined as such because they are associated with femininity. Nor are different parts of heating systems more to do do with 'facility management' or 'home making' than any others. (Offenberger & Nentwich, 2009) In gender scripts, dealing with technologies in this way represents a means by which individuals discursively maintain 'feminine' (non-technical) and 'masculine' (technical) as coherent identities. (Heinzle, Känzig, Nentwich, Offenberger, 2010; Offenberger & Nentwich, 2009) However, while gender scripts are presented as capable of shaping behaviour, ultimately they are conceptualised as discursive constructions through which individuals attempt to make sense of their own behaviour. This means that they can reconstruct gendered interests and behaviours as being different, despite the fact that the underlying practices these constructions are based on are actually very similar between men and women. Within the household, Offenberger and Nentwich (2009) found that women and men both involved themselves with the 'technical' and 'aesthetic' concerns that would normally be placed in the domain of the other gender. A female interviewee were found to have expertise and experience in using biomass stoves effectively, while a male interviewee concerned themselves with the aesthetics of lighting. However, both were resistant to these framing of their actions and attempted to discursively associate or dissociate themselves from the 'technical.' Women and men don't by any means always conform to gender norms, and the gendering of objects, domestic activities and areas can lead identical behaviours to be perceived differently. It is argued that gender scripts and their potential masking effects should be taken into account when considering the question of gender in the energy context. (Offenberger & NentwIch, 2009; Prietl, 2017)

These findings represent the little evidence on gender differences in energy behaviours; however, the findings of Carlsson-Kanyama and Lindén (2007), and Tjørring, Jensen, Hansen and Andersen (2018) are nonetheless significant for this field of research. Women are still primarily responsible for household chores, which are the most energy intensive household practices; therefore, investigating the obduracy of these energy practices is an important task (Bell et al., 2015; Dunphy, Revez, Gaffney, Lennon, & Aguilo et al., 2018; Ellegård & Palm, 2015; Tjørring, Jensen, Hansen & Andersen, 2018) The intersectional analysis of Dunphy, Revez, Gaffney, Lennon, & Aguilo et al., (2018) added some nuance to the image of the division of labour that appeared to occur along traditional gender lines. The authors found that younger fathers generally expressed that they spent more time with tasks like cooking than older men, and generally did not so strongly perceive these tasks to be women's work. This suggests that there are some differences in how practices are divided between the genders

according to age, and this is seen as demonstrating that gender roles are not set in stone and may change over time. Therefore, the changing of gendered divisions of household energy practices is also worthy of attention, as is how divisions of labour could potentially be shifted or reinforced by particular interventions. (Dunphy, Revez, Gaffney, Lennon, & Aguilo et al., 2018; Tjørring, Jensen, Hansen & Andersen, 2018).

Energy and Gender Equality

The studies discussed above demonstrate that men and women may differ in their attitudes towards certain energy technologies, and in their willingness to change their energy practices. More clear, are the differences in their energy use behaviours, both with regards to the amount consumed by men and women, and the energy-consuming practices they engage in. This is true both outside of, and within the household, where household labour and engagement with energy technologies remain strongly divided along gender lines. These divisions remain when we approach changing energy consumption in the household. Men are predominantly responsible for energy efficiency upgrades in the home, or the installation of energy technologies like solar panels, while women are instead responsible for changing their practices, and those of the other members of the household. These differences are important when considering the equality of the genders, from the perspectives of procedural and distributional justice. (Fraune, 2018) Firstly, when considering procedural justice, and as argued by Clancy and Roehr (2003), what becomes important is not the differences in attitudes and needs themselves but the relative abilities of groups to shape their lives according to these preferences. A central aspect to this is the ability of men and women to influence decision making, whether in their personal lives, through energy research, in the energy sector itself, or in the policy sphere. When considering distributional justice, we instead look at questions regarding the relative distribution of the benefits and negative effects of energy systems. The division of energy practices by gender, and the different degrees of engagement with energy renovations and technologies exhibited by men and women already imply that any energy interventions or policies will not be gender neutral, and are going to affect men and women differently. Scrutinising how the benefits, limitations, and burdens of these interventions are apportioned only becomes more important as increasing attention is paid to targeting energy interventions according to gendered divisions of energy practices. (Tjørring, 2016; Tjørring, Jensen, Hansen & Andersen, 2018) More broadly, the literature addressing energy and gender equality recognises the different vulnerabilities and constraints experienced by men and women, and the resulting patterns in participation, advantage and disadvantage that emerge.

Procedural Justice: Women's Participation and Representation

The reasons behind women's lower participation in STEM research and industries, and in the political sphere is an ongoing research area that won't be addressed directly here. However, what will be addressed is research that delves into how differences in participation between women and men may affect decision making and policy outcomes, and also how the underrepresentation of women in energy related spheres, as well as the ways they are represented, might affect their ability to take advantage of opportunities offered by the 'energy transition.'

Gender and Participation in Decision-Making

Differences in the ability of men and women to make decisions regarding energy becomes readily apparent in the distinct absence of women in managerial roles in energy companies, and their underrepresentation in the policy sphere. (Anfinsen & Heidenreich, 2017; CarlssonKanyama & Röhr, 2010; Clancy & Roehr, 2003; European Institute for Gender Equality, 2012; Fraune, 2016) Representing both genders equally in decision-making spheres is seen as important to ensure that decisions are not made solely according to the 'norms and values' of one gender. The argument has also been made that beyond providing procedural justice, an important goal in and of itself, the inclusion of women in the decision making sphere may benefit decision making; particularly in the field of energy. For example, Carlsson-Kanyama and Röhr (2010) suggest that the greater involvement of women might shape, and even improve decision making in the context of the 'energy transition' due to their greater perception of risk, and their, on average, greater concern for the environment. Women's greater focus on environmental issues, is also apparent in energy-related research, and female scientists also strive to include social issues into their work to a greater degree than men, rather than focusing exclusively on technological aspects. (Clancy & Roehr, 2003; Offenberger & Nentwich, 2010) Overall, these findings imply that increasing the participation of women might be positive for achieving environmental goals. (Clancy & Roehr, 2003) However, the question of whether women's participation in research, industry or politics leads to different outcomes remains understudied, and this lack is even more stark when focusing on the area of energy. (Carlsson- Kanyama & Röhr, 2010)

Fraune's (2016) comparative analysis of gendered difference in energy policy-making in Germany and the US, is an attempt to address exactly this question. Fraune asks 'does a greater representation of women result in a genuine change or does nothing become fundamentally different?' (pp.134) Essentially, do the different values, attitudes and needs of women become reflected in their legislative choices and the resulting legislature? This is an important question when we consider the body of literature that laments women's lack of representation in decision making bodies, as there is an underlying belief that their integration will lead to significant change, and to outcomes that are more closely aligned with women's values and interests. This is a belief that has yet to be validated, and there is some suggestion that women who do manage to enter into male-dominated spheres tend to act according to the institutionalised 'masculine' norms that characterise them. (Magnusdottir & Kronsell, 2015) Therefore, there is a danger that prioritisation of participation could fail to integrate women's interests while other potential pathways are neglected. Furthermore, advocating solely for representation can act as a 'get out of jail free card' that releases decision-makers in the field of energy from the responsibility of investigating and attempting to represent women's interests. This is a danger that emerges when representation becomes a means by which the female 'other' is painted as completely unknowable by anyone of a different gender.

Fraune (2016) sought to gain insight into the effect of women on energy policy making by analysing two factors: voting, and number and length of speeches on particular topics. She found that women and men voted differently according to their gender. These results were consistent when controlled for country; however, this differences disappeared when controlled for by party affiliation. Fraune suggests that this may indicate a lack of difference in preferences for energy policy by gender, or might instead indicate that men and women exhibit different preferences for party affiliation. Nonetheless, she argues that this would need to be

investigated more thoroughly before it could be attributed to gendered differences in attitudes, as factors like party recruitment policy will have their own effects. With regards to number of speeches, Fraune found that in both cases, the number of speeches given was proportional to the representation of gender. However, in Germany, women gave speeches that had a lower word count than in their male counterparts, while in the US there was no significant difference between the men and women. Fraune posits that this might represent a manifestation of previous findings that women tend to attempt to compensation for their underrepresentation by increasing their speech making activities. The US and Germany differ greatly in their energy policy paths, with renewable energy pathways being given a much higher priority in Germany than in the US and are generally of more importance to women. Fraune argues that women's greater presence in speech making in the US could be seen as an attempt to instead compensate for the underrepresentation of their policy interests and priorities regarding energy. As noted by Fraune, these quantitative results only give an indication that there are gender differences between speech giving behaviour, and that this kind of quantitative analysis is not well suited to meaningfully explaining why these differences might exist. However, it offers a basis for conducting further qualitative analysis, which could give a greater insight into the substance of the difference, and the reasons behind them. This study could therefore represent a starting point for what could prove to be a fruitful area of research.

Presently, there exists some very preliminary evidence that the participation of women in energy related spheres might influence the priority given to the environment, the social and considerations of risk. (Carlsson-Kanyama & Röhr, 2010; Clancy & Roehr, 2003; Fraune, 2016; Offenberger & Nentwich, 2010) However, further research is needed before any real conclusions can be drawn. Furthermore, any findings will need to be analysed in light of evidence that points to the constraining effect of the masculine norms of the energy sector, which also needs careful consideration. This work suggests that increasing women's participation may not be sufficient for significantly altering decision-making outcomes. (Magnusdottir & Kronsell, 2015) Instead, there will need to be a conscious uncoupling of 'masculinity' and 'femininity' from certain types of concern and forms of problem solving, or, failing that, a deeper scrutiny of how their legitimacy is assessed. Otherwise the 'masculinisation' of energy overall, and of certain types of energy technology over others, will continue to dictate, and constrain how problems and their potential solutions are identified, valued and prioritised. (Anfinsen & Heidenreich, 2017; Magnusdottir & Kronsell, 2015; Prietl, 2017; Ryan, 2014; Standal et al., 2018) Finally, the link between increasing women's representation in these spheres, and any differences that emerge in their choices with regards to men cannot automatically be equated to the representation of 'women's' interests. Not only has research on 'women's' attitudes and preferences remained inconclusive, but 'women' are not a homogenous group. Therefore, it is important to recognise that women's experiences, and therefore needs and interests are produced as a result of other intersecting factors like class and race and are likely highly diverse. Acknowledging, and understanding the nature of these diverse experiences, needs, and interests is essential if 'women' are to be represented in any meaningful way. (Clancy, 2003)

Representations of Gender

How men and women, and their respective relationships to energy are represented in policy documents, promotional material, and other media, has also been presented as a key consideration when discussing gender equality. It has been argued that media that reproduces stereotypical gender roles in relation to energy technologies can inhibit the adoption of energy technologies, and the transition to more environmentally-friendly patterns of energy

consumption. Therefore, the analysis of this kind of material is seen as an important avenue for further research, as is investigating how it may be used as a resource for reducing gender imbalances. Standal et al., (2018) explored how women and men are presented in policy documents, promotion material for home solar power plants (HSPPs), and in media content about HSPPs and prosuming. In policy documents, they found that language was gender neutral and that all needs, values, constraints and capacities were considered to apply equally to both genders. In promotional material and the wider media, they found that women featured much more rarely than men, and the presentations of gender largely reflected stereotypical gender roles. Women were more often pictured in the private, and particularly the household sphere, and generally were presented as engaging in prosuming as part of the family, and as the 'wife.' Their motivations were also limited to environmental concerns. The presentation of men and their motivations and skills were more varied, and could be environmental, technical, or financial. In these materials, those presented as having expertise or interacting with solar panels were nearly exclusively men. Standal et al., (2018) argue that such limited and stereotypical forms of representation can lead to the exclusion individuals who don't find themselves represented, and therefore can act to reinforce gender norms. Despite these findings, the authors also expressed optimism that the diversity of the presentations of gender and values were increasing as bigger multinational companies like IKEA entered the market.

Distributional Justice: Benefits and Vulnerabilities

So it's currently not possible to say if, how, and to what extent women influence decisionmaking in the energy sphere, and therefore how changes in participation might affect women's status as a group who benefits from, or is disadvantaged by energy policy, research, and industry. These remain important areas for further research. Nonetheless, there is a small body of research that has begun to analyse how men and women have been differentiated in terms of their vulnerabilities with regards to energy, as well as their ability to take advantage of the opportunities and benefits offered by the energy sector.

The Energy Transition

The fact that women are underrepresented in the energy sector means that they are less likely to benefit from new jobs created in this sector, as evidenced by the fact that women's low participation has continued as the renewable energy sector has grown. (Fraune, 2018) This is perhaps not a groundbreaking realisation; however, the lower representations of women in STEM is an expression of, and can perhaps perpetuate the limiting effects of gender norms. A lack of engagement in STEM fields, and the characterisation of energy technologies as 'masculine' can further constrain women's choices in the respect that women may then be less likely to adopt and engage with energy technologies. For example, in the case of solar panels, Standal et al., (2018) found that professionals who are employed in technical industries, or those who consider themselves to be technically skilled, represent a large proportion of those who become prosumers. Women are therefore less likely to become prosumers, and represent a significantly smaller proportion of prosumers than men. There has also been some speculation that lack of experience in STEM fields made also limit the strength of women's candidacy for decision making roles in citizen participation schemes for renewable energy production. (Fraune, 2015) This has prompted questions in the literature concerning what constraints act upon women relative to men, and how they might be alleviated to increase women's participation in these areas.

Fraune (2015) investigated the contributing factors to gender differences in involvement in citizen participation schemes for renewable energy production. The analysis aimed to move beyond individual decision-making processes and gain insight into how the wider cultural, political, and social context might influence and constrain individual agency, and so individuals' abilities to engage in these projects. Women were underrepresented as both investors and key decision makers within the schemes and provided less capital though differences in per capita contribution by gender were inconclusive. Women were also found to be more likely to invest in certain corporate types: they tended to favor cooperatives (eG) over civil law associations (GbR), the latter of which are considered to be higher risk investments. Fraune situates these finding with relation to the fact that in the German context, the key to participation in citizens' renewable energy projects is the investment of equity. She argues that, therefore, analysing the influence of the wider context necessarily turns us to gender differences in employment: the gender wage-gap, and the gendered segregation of types of occupations and leadership positions. Fraune posits that the results of the study can perhaps be seen as reflective of an environment where women accrue significantly less capital and power than men, and therefore have less agency to take the financial risks necessary to engage with these projects. The German case proves that these projects are not automatically democratic and egalitarian, and it may be necessary to actively redress social imbalances within the schemes to ensure that different groups have the opportunity to benefit from them equally.

Gender norms and gender scripts are also an important focus, alongside considerations of differences in capital, economic and labour market segregation. It is argued that the 'masculinisation' of technologies, and, importantly, particular types of technologies can limit women's engagement by painting their engagement as at odds with gender norms and 'femininity.' However, the scripting of technologies like solar panels as 'masculine' is by no means intrinsic or set in stone, nor is this characterisation necessarily an impenetrable barrier to their adoption by women. (Offenberger and Nentwich, 2009; Henning, 2004) The point made here is that these categorisations are mutable and this points to the importance of developing policies that aim to engage and support women specifically. This includes presenting women in a greater variety of roles in promotional materials; roles which present women as experts and engaging directly with technologies, alongside more traditional presentations of women in a family setting. (Standal et al., 2018) Meaningfully engaging with these issues is seen as key, not only for gender equity but also for achieving a wider uptake of decentralised energy systems. Engaging more women means having more advocates for the adoption of solar power within nuclear households, and could become more important in a society where single adult, childless households are on the rise, and currently account for 30% of households in the European Union. (Eurostat, 2015)

Gender and Energy Poverty

An important element to the discussion of energy and gender equality is women's increased vulnerability to issues regarding energy. Similarly to the global South, there are more women in poverty than men. Throughout the EU women have, on average, 16 % less disposable income than men, ranging from 23 % less in Germany, Estonia and the Czech Republic to 4 % less in Malta. (Röhr and Hemmati, 2008) Women are also more likely to head two-income single parent households or single person households at pensioner age. Low income households often face restrictions in accessible forms of energy, and pay higher tariffs for their energy access, which is therefore an issue that will disproportionately affect women. Lower

income households are also more likely to live in buildings with poor insulation and heating systems, and purchase cheaper appliances. This means that poorer households are generally living in houses, and using appliances that have poor energy efficiency ratings. Ultimately, these factors can can lead to fuel poverty, as low income households essentially pay more to perform energy consuming activities with inefficient appliances, and to achieve adequate levels of heating or cooling. More women than men report not being able to adequately heat their homes, and beyond personal comfort, an inability to heat or cool the home can be a serious danger to health, with the elderly and the very young being most at risk. (Clancy & Roehr, 2003; European Institute for Gender Equality, 2012; Röhr & Hemmati, 2008) Women's overrepresentation in these at risk groups means that they constitute a significantly larger proportion of excess deaths due to extreme thermal conditions. (European Institute for Gender Equality, 2012; Röhr & Hemmati, 2008) For example, during the 2002-2003 heatwave in Portugal excess mortality was twice as high amongst women. (Nogueira, Falcão, Contreiras, Paixão, Brandão & Batista, 2005)

Taking differing levels of income into account is important in and of itself, but it is also necessary to take into account its gendered nature. Recognising the difference in women's and men's economic statuses is essential for assessing how issues such as energy poverty should be addressed, as well as how the potential effects broader policies concerning energy might differentiate according to gender. Particularly essential, is scrutinising their potential for widening or narrowing gendered disparities in income and power. (European Institute for Gender Equality, 2012)

Gendered Effects of Energy Policy

The differences in average income, and financial assets between men and women give us our first insight into the importance of analysing the effects of energy policies according to gender. As with other areas of research on gender and energy, there are very few empirical studies. In addition, discussions of the gendered effects of energy policy predominantly go no further than analysing the percentage of women that have changed their behaviour in response to a policy in comparison to men. Any further discussion of energy policies on the lives of individuals may call for more detailed analysis, but nonetheless often still remains purely speculative. (European Institute for Gender Equality, 2012)

There is a general, and not unreasonable, assumption that measures that lead to greater personal expense are likely to disproportionately affect women due to their lower average income, which perhaps explains women's greater responsiveness to economic disincentives. (Carlsson-Kanyama & Lindén, 2007; Lee, Park & Han, 2013; European Institute for Gender Equality, 2012) There is also a concern that these kinds of policies can only lead to reduced energy consumption when the individual in question has the means to do so. Impoverished individuals are likely to have already minimised their energy consumption to the greatest degree possible, and are often incapable of further reducing their energy consumption by upgrading their appliances or their homes to be more energy efficient. This may be due to cost constraints, or additionally, in the case of home renovations, the fact that a high-proportion of low-income households don't own their homes. Without meaningful policies aimed at supporting low-income groups, the majority of which are women, these types of energy policies can push people into energy poverty. (European Institute for Gender Equality, 2012) Similarly, low-income can act as a limiting factor for women adopting energy technologies like solar panels, which require a significant initial monetary outlay but may ultimately prove to be

beneficial in the long-run. (Carlsson-Kanyama and Lindén, 2007; European Institute for Gender Equality, 2012; Fraune, 2016; Röhr & Hemmati, 2008; Standal et al., 2018) Difference in average income is not the only factor that has been identified in the literature as a potential dictator of the gendered impacts of energy policies. The still prevailing divisions of labour within the household, and the construction of energy efficiency upgrades or energy technologies as the purview of the 'masculine' will have important implications for how energy policies interact with gender. (Anfinsen & Heidenreich, 2017; Carlsson-Kanyama & Lindén, 2007; Standal, 2018 Vinz, 2009)

'Sufficiency' measures that focus on energy conservation have been almost exclusively directed at the household sphere, and very rarely industry. Instead industry is expected to reduce overall consumption through efficiency measures, and technological development. This has resulted in concern that these policies could result in the 'feminization of responsibility for the environment,' whereby women, who are still responsible for the majority of household labour, bear the brunt of policies that demand that energy savings should predominantly be made in the residential sector. (Vinz, 2009, pp.163) Carlsson-Kanyama and Lindén's (2007) study is one of the earliest, and one of the few studies that seeks to analyse how men and women may be affected differently by these kinds of policies. They conducted a gendered analysis of the experiences of households who participated in various different energy conservation schemes in Sweden, and found that gender differences did emerge with regard to acceptance of greater discomfort or workload. Gendered differences in discomfort and workload manifested themselves in two key aspects. The first is that women experienced greater discomfort than men, having lowered the thermostat to conserve energy, a finding which is consistent with findings that women have greater thermal sensitivity. (Karjalainen, 2012) Women adapted to it by wearing extra clothing but, nevertheless, often still experienced discomfort. The second finding was that gendered divisions of abour in the household meant that the burden of changing these practices fell predominantly on women. The use of clothes driers was abandoned in an effort to save energy, and the timing of doing laundry was altered in order to take advantage of lower energy tariffs. This led to increased labour for women as they had to hang out clothes to dry, and often got up early to do so as they had to deal with laundry that they put on overnight. In many cases this task needed to be performed before they went to work, meaning that it became a much more time-consuming and labourious task. In this case, the burdens of reducing household energy consumptions fell predominantly on women due to their disproportionate responsibility for household work, a situation that is only exacerbated for women in the labour force.

In a similar study, and in contrast to Carlsson-Kanyama and Lindén, (2007) Tjørring, Jensen, Hansen and Andersen found that women didn't report an increased workload, as the timing of their use of washing machines and tumble driers changed, not the amount that they were used. However, they did note that female participants explained their behaviour by saying they didn't want to deal with 'wet clothes late at night when they were tired.' (2018, pp.15) This arguably suggests that women experience increased discomfort when performing this practice late at night to take advantage of lower energy tariffs. However, the different results reported by these two studies could perhaps take on more significance if they are compared more closely, as the two interventions looked at in the studies were actually very different. Tjørring, Jensen, Hansen and Andersen's (2018) study looked at households who were encouraged to change their patterns of energy consumption to take advantage of cheaper energy tariffs. In contrast, the participants of the 'New Energy Habits' scheme who were interviewed by Carlsson-Kanyama

and Lindén (2007) were aiming specifically for an 10% absolute reduction in energy consumption. In this respect, comparing the two studies might provide an insight into what circumstances and for what reasons individuals might reduce their consumption, as well as indicating what types of policies might exacerbate existing inequalities and how they might do so. This illustrates the importance of building gender into analyses of the effects of a wider range energy interventions, and bringing them meaningfully into conversation with each other. These kinds of analyses will open the door to designing more effective energy policies and interventions, and can also be used to produce more equitable ones. Both energy-related, and gender equality goals could be served by encouraging changes in the distribution of energy practices by gender as a component of changing household energy practices overall. Not only could this result in a more equitable distribution of labour, it could act to reduce barriers towards changing energy behaviours in the household by distributing any increase in workload across two or more individuals. (Anfinsen & Heidenreich, 2017)

Concluding Remarks

A number of interesting findings and areas for further research have been identified in the literature covered in this review; however, gender and energy in the context of the global North is still clearly an emerging research area. As it was when Clancy first asked 'is there a Northern perspective?' (2003, pp. 44) the field is characterised by a lack of empirical research, and particularly empirical research that meaningfully engages with the question of gender, or moves beyond analysing gender in the context of the household. Moving beyond this point means continuing to build a body of research that move beyond treatments of gender as an analytical category, or quantitative studies that take a gender-related difference as 'ipso facto saying something so obvious about men and women that one can report a statistically significant gap without further comment.' (Henwood & Pidgeon, 2015, pp. 11) This particularly means engaging in more research that analyses the effects of power imbalances in gender relations, and of gendered stereotypes and assumptions regarding gender. There is a particular call for increasing the proportion of qualitative research in this field, as it has been argued that it has potentially more power to explain why gender differences might occur. Currently, studies that are not based on survey methods tend to be fairly limited in scope and focus on a single energy technology, intervention or only concern a handful of individuals or households. There is also a strong focus on the Nordic context; however, studies have begun to emerge which focus on other European countries and conduct comparative analyses across different contexts.

During the course of this review we've seen evidence that women are responsible for a larger proportion of household energy consumption, and report a higher willingness to change their energy practices and to encourage change in others. This has made women as a group an increasingly attractive target for energy interventions, and while the differences in their situations should not be understated, we can see echoes of the same trends in literature focusing on the global North that were criticised when they emerged in the literature concerning women and energy in the global South. (Cecelski, 2004) Namely, that women and their experiences are only of interest when they are to be instramentalised as a means to ensure the success of a project, in this case, the 'energy transition.' A focus that can go some way to explaining the high proportion of energy and gender literature that analyses the household. We find ourselves in a problematic situation where the household, and therefore women are expected to bear the brunt of demands to reduced energy consumption, often without this

being specifically recognised. ‘The household’ and ‘the consumer’ being the preferred terms that actually mean ‘women’ when considering the distribution of labour in the household. This ‘feminization of responsibility for the environment’

(Vinz, 2009, pp.163) occurs despite the fact that women have very little participation in the decision-making that distributes responsibility in this fashion, and ultimately experience very few of the benefits offered by the energy sector. Women still hold a very low proportion of jobs in the energy industry, and their share in the renewable sector remains small despite early optimism. (Fraune, 2018) Low representation continues into areas like investment in renewable energy schemes, despite evidence that women are perhaps more willing than men to engage in other environmental schemes. Similar issues appear when considering women’s engagement with decentralised solar energy. Women report themselves as less likely to install solar panels, and evidence has shown that this holds true in practice. Building an energy system, and an ‘energy transition’ that embodies gender equality is not only about designing policies and energy interventions that don’t disadvantage one gender over the other. Instead, as much is possible, it should mean changing gender relations and improving women’s position in society relative to men.

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Review

Literature Review: Gender and Robotics

Anna Pillinger

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Contents

1 Introduction

> I'm for more women in robotics, not for more female robots.[10]
>
> - Martina Mara (2017)

Therobopsychologist Martina Mara made this statement during an interview and similar comments are not hard to find in many technological fields. And although it is a pressing issue, this review deals instead with the second part of Mara's statement, or rather, with its consequences: the female robots. To be precise, the aim of this review is not to present female robots, but to tackle the topic of robots, and especially gendered robots from different, however mainly feminist or gender-sensitive perspectives, since these perspectives are mostly sidelined in the technical literature. This report aims to highlight the most relevant discourses on the topic of gender and robots. In order to sensitize readers, I would like to quickly mention that when following Butler (cf. 2006) or taking Queer Theory into consideration, sex and gender are socially constructed. Furthermore, it is necessary to mention that not merely two or three gender identities exist, but rather, many more.

1.1 Definitions and Demarcations: Robots and Non-Robots

This literature review deals exclusively with the artifact "Robot", which the IEEE (In- stitute of Electrical and Electronics Engineers) defines as follows:

A robot is an autonomous machine capable of sensing its environment, car- rying out computations to make decisions, and performing actions in the real world.("What Is a Robot?", 2019)

The IEEE further highlights the non-triviality of such a definition, since what is or isn't a robot, is not always uniquely definable, even for roboticists. To offer a further defi- nition, I would like to present Janina Loh's (2019). Loh is a philosopher of technology, working among other things on robot ethics. For her work, she defines a robot as follows:

I define a robot as an electro-mechanical machine with a) a body, b) a pro- cessor, c) sensors, that collect data, d) and an effector or actuator, that translates signals into mostly mechanical operations. The robots behavior is or at least appears to a certain degree autonomous. It can, therefore, act on the environment in a way that computers cannot. (Loh, 2019)

While, most aspects overlap with the definition presented by the IEEE, she adds that the appearance of autonomy suffices for her analysis. This (appearance of) autonomy is a very relevant factor in social robotics or ethics and the accompanying issue of deception, which is often revisited in the analysis of care robots in a surrounding where children or those suffering from dementia could potentially be "deceived" by the robot.

Robots are mostly "equipped" with what is often called an artificial intelligence or the ability to "learn", e.g. via machine learning algorithms. Many people from the field also claim that in order to be considered a robot, it must have some kind of "artificial intelligence".

[10] https://ars.electronica.art/aeblog/en/2017/03/08/women-robotics/

Given these comprehensive definitions, I would like to narrow the subject of the cur- rent review. Gender bias is a frequently discussed topic in literature surrounding the field of Critical Algorithm Studies. Due to unbalanced training data, sexist and racist outcomes can be seen in many cases (cf. Noble, 2018; Allhutter, 2018). An example for such bias, which raised awareness in 2016, was that the google image search for the terms “unprofessional hairstyle” resulted in images of black women (Alexander, 2016). Three years later, when searching these terms, one finds references to this story instead. How- ever, when I google “professional hairstyles” today (2019), the results show primarily white men.

In addition, I want to distinguish my topic from adjacent fields or technologies, which would also be intriguing to scrutinize further, such as virtual assistance or AI. The UNESCO [11] published a program and meeting document concerning these topics, which is openly available.

Another figure, which is not a robot, but still important to mention, is the cyborg (= cybernetic organism). In many ways it is distinct from a robot, and moreover, an android, which is a robot resembling a human. I understand cyborg as a somewhat altered human (potentially also animal or plant), enhanced with technologies. To further elaborate on this, one would have to consult literature dealing with post- and transhumanism (cf. Loh, 2018). Also, the question concerning “the gender” of a cyborg is profoundly different than the question about “the gender” of a robot. Aside from what Donna Haraway (1991) claims - namely that a cyborg lives in a post-gender world - a cyborg is able, in contrast to a robot, to self-identify as a certain gender (or not).

1.2 Queering Gender and Sex

To begin with, there is no unique definition for sex and gender, or for their intertwining or distinction. Different views can be identified concerning this topic. For the purpose of this review, we define sex as the biological dimension of a human body, where sex char- acteristics are present that are considered as male, female, or intersex. Gender is defined as the norms and expectations that relate to its expression in behaviour, gestures, lan- guage, feelings, and physique. Gender thus refers to (stereotypical) characteristics that are tied to social expectations regarding adequate and inadequate behaviours, attitudes and preferences. The term gender (often described as a reference to cultural attitudes and behaviours) as opposed to sex (mostly refers to biological characteristics), gained popularity from the 1960s onwards as an opposition to biological deterministic views on the biological sex. However, while it is said that sex and gender mutually shape one another and gender is mostly seen as socially constructed, Judith Butler (cf. 1990) takes the assumption one step further and claims that both sex and gender are socially con- structed. She cites Simone de Beauvoir, who said “One is not born, but rather becomes, a woman”.

Literature in the field of Human-Robot Interaction often does not distinguish between the terms “sex” and “gender”, but instead uses them interchangeably, with what seems to be a preference for the term gender. Beyond this lack of reflection on gender and sex, the categories of “female” and “male” seem set in stone, even for robots in some instances, while neglected is that many more gender identities are present and should be included.

1.3 Sensitizing Concepts

[11] https://unesdoc.unesco.org/ark:/48223/pf0000367416

This section will present important literature from the umbrella term “feminist techno- science”, which deals with human-robot interaction and promises of technology.

1.3.1 Drawing Together Feminism and Technoscience: Donna Haraway’s Cyborg Manifesto

Although this literature review deals with robots - not cyborgs, Donna Haraway’s (1991) Cyborg Manifesto was a pioneering work in feminist technoscience, which serves as a beneficial basis for thinking about feminist issues in robotics, since it sheds light on the intersections between human and machine. With her trope of the cyborg, Haraway aims to recognize the blurring of boundaries, such as “male/female” (ibid., p. 177), animal/machine, or human/machine.

Distancing herself from technological deterministic views (i.e. that technological change implies socio-cultural change), Haraway imagines a postgender world due to dissolving boundaries. To date, this does not hold true, as parts of the literature review suggest. However, keeping the “promise” of the cyborg and its emancipatory character in mind could foster sensitivity in the design of technologies when it comes to gendered aspects, and a reproduction of stereotypes.

1.3.2 Drawing Together Feminism and Technoscience: Lucy Suchman’s Human Machine Reconfigurations

Lucy Suchman, an anthropologist of science and technology, has focused her work on critically engaging with “projects aimed at constructing computational machines as sen- tient others” (Suchman, 2006) since the late 1970s. What makes her work interesting for this literature review, is her analysis of the creation of human-like machines. While roboticists often see robots as models of the human, Lucy Suchman wants to see, what is imagined as human through the eyes of roboticists. In her chapter on “Figuring the Human in AI and Robotics” (Suchman, 2006), she reflects on the main characteristics implemented into machines in order to create something human-like. Key attributes Suchman identified are: Embodiment, Emotion, and Sociability. Famous examples for the latter were Cog and Kismet[12], located in the MIT’s Artificial Intelligence Laboratory. At a talk in 2006 at the IEEE, Suchman highlights the need for demystification. She underlines this need by contrasting representations of these robots with actual encounters in the lab. While Kismet’s videos on the website promise authentic interactions between Kismet and its principal creator Cynthia Breazeal, Kismet was much more unreliable when visiting it in the lab. “These re-enactments thereby imply that thecapacities they record have an ongoing existence; that they are themselves robust and repeatable, and that like any other living creature Cog and Kismet’s agencies are continuing to develop and unfold.” (ibid., p. 653)

1.3.3 Caring about Robots: Jutta Weber’s Helpless Machines and True loving Caregivers

For Jutta Weber (2005) - whose analysis remains up-to-date - Human-Robot-Interaction is a field with increasing popularity, “An interdisciplinary field that lies between robotics, AI, cognitive science, (developmental) psychology, user testing, biology (esp. ethology), and partly sociology” (ibid., p. 210). In contrast to earlier accomplishments in robotics and AI, which can be allocated to rather rigid, rule-oriented, symbol-oriented yielding to an adaptive human

[12] http://www.ai.mit.edu/projects/sociable/baby-bits.html

behavior towards the machine, recent trends are moving towards social robotics. Social robotics is seen as a solution to increasing complexity, yielding an easier and more intuitive user interface. Problems demarcated by Weber are located on the one hand in gender stereotypes, which become embedded in the robots, as will be discussed in the next chapters, and on the other hand in typical relations presented in Human-Robot-Interaction. Jutta Weber's analysis showed that when it comes to sociable robots, two kinds of relations are predominant, namely the "caregiver-infant relationship" and the "owner-pet relationship". When moving this analysis to current discourses of sociable robots, a third category might arise, when thinking about sex- robots and the thereby implied relationship.

> The question here is whether it is desirable that people invest such a huge amount of time in educating their personal robots so that they might be- come (more) intelligent. In a way, it is a kind of clever outsourcing, which enrolls the user in the time-consuming adaption of the personal robot to its environment and gives her or him the feeling to develop one's own artifact. (ibid., p. 210)

This quote is especially interesting, since it makes visible the tension between the in- volvement and exclusion of users. The former was often demanded by feminists in technoscience. Weber claims that "Social roboticists want to exploit the assumed hu- man tendency of anthropomorphising machines and interacting with them in a social way by shaping them either woman-like, like an infant or like a pet." (ibid., p. 211) This is very much in line with literature suggesting that e.g., a "male" robot might seem threatening in the domestic environment (Carpenter, 2009). For that reason it seems logical, that roboticists make use of the so-called Baby Scheme, meant to trigger nur- turing responses from the user.

The reason for presenting these works at this stage of the review is, to emphasize the blurring of boundaries, the conceptualization of what is human and how this humanity is imagined in building humanoid social robots and relations between humans and robots.

1.4 Excursion: Media Equation Theory

Although this theory is not highlighted in feminist or gender-sensitive literature, it ap- pears to be prevalent in papers dealing with Human-Robot-Interaction (HRI), since it makes a strong claim about our interaction with machines. In this section, the theory

will be outlined briefly and links to relevancies in dealing with robots from a feminist perspective will be displayed. This popular theory was co-created by Byron Reeves and Clifford Nass, both professors of communication science. Basically, they claim that "We respond to communication media, media technologies, and mediated images as we do to actual people and places" (Littlejohn & Foss, 2009, p. 635). To prove this hypothesis, the scholars looked at existing work in the field of psychology dealing with Human-Human- Interaction and substituted one of the humans with a media artifact. Interestingly, they arrived at similar results. One example would be that manners, including politeness, arises in a similar way when confronted with a computer or a human being. Test sub- jects were meant to solve a problem with a computer and later evaluate the capability of the device. Those who did the evaluation on the same computer on which they had solved the problem evaluated it better than those who did the evaluation on a different PC. Dozens of studies were able to replicate similar results in the 1980s and 1990s. In line with the aim of this review, also gender was an issue in some of these

studies, since although the devices do not have an actual sex or gender, people were reacting to gender cues according to prevalent stereotypes.

The theory is often summarized as media = real life. I claim, however, that the conducted studies might not prove this equation, but rather, the implication real life -> media. The other direction might be the more crucial one, for the endeavor of this review. Here, the question arises of whether the stereotyped robots, as will be presented later, and the interaction with them, will influence human-human interaction, too. For example, when thinking about care robots or sex robots.

2 Gender & Robots

A great amount of literature deals with the topic of **Gender in Robotics** in a rather uncritical way at least when the intention is to consider the topic from a gender or feminist theory perspective, as study designs often reproduce heteronormative, binary gender stereotypes. When going through the literature, thisperspective seems inevitable. As Jennifer Robertson (cf. 2010, p. 5) correctly points out, most of the literature that can be found when looking explicitly for gender AND robots are studies dealing with **Human-Robot-Interaction**, more precisely A) the interaction of people towards feminine versus masculine robots; B) differences in the interaction of females versus males towards robots; or a hybrid of those two. Although her observations are more then ten years old, things look similar today. However, I would like to highlight a further strand of literature, coming from different fields such as **Gender Studies, Culture Studies, Science and Technology Studies**, and so forth investigating the issue on hand from a perspective that goes beyond the findings from strands A & B and looks at implications for society and coping mechanisms. In this chapter, I want to give an overview of the mentioned strands of literature, beginning with the more technical ones, to continue with the societal perspectives and end with suggested solutions, as can be found in Londa Schiebinger's recent report.

2.1 Humans interacting with Robots and Robots interacting with Humans

In the following, I reflect on sensitivities, implications and consequences of research that is not aware of broader societal and in the case of this literature review, gender specific issues. It is obvious that the roboticist is the expert when it comes to robots and building them. This does not mean, however, that they have enough expertise to gender a robot. Therefore, collaboration between the different experts must be encouraged.

Tatsuya Nomura (2017) provided an overview as well as a classification, on how gender is reflected on and used as a category in HRI. For this, he consulted literature from the field of Human-Robot-Interaction and clustered as well described it. Similar to my outline in the introduction, he found the following categories and subcategories:

i) Robot Gender: This means looking at the implication of male vs. female (or neutrally) gendered robots on the users acceptance of them. A further category of gendering robots for the author is so-called "simple gendering" (ibid., p.18), which means assigning a gender only by name-giving and voice.
ii) Human Gender: This strand of literature investigates the acceptance of robots depending on the gender of the user.

iii) Interaction Effects: They can be manifold, such as using both the “robot gen- der” and the “human gender” as a parameter, or adding other factors such as age, socioeconomic status, or situational factors.

In each section, Nomura presents current research done in the field of HRI and dis- cusses the results. These results most frequently reproduce existing gender-stereotypes, especially when it comes to “typically male” vs. “typically female” tasks. This experi- mental setup should itself be viewed critically. In other cases, researchers were able to find a so-called “crossgender effect” (ibid., p. 22), which means that female participants preferred the ”masculine” robot, whereas male participants preferred the”feminine” one. Examples for this are “masculine” security robots and “feminine” domestic robots. Most of the literature presented does not reflect on the perpetuation of gender stereotypes in their study design. Although the author reflects on the necessity of focusing on differ- ent cultures, he draws the problematic reasoning from his literature review that “When considering robotics applications in a specific area, one should also focus on cultural influences to maintain gender stereotypes related to that area” (ibid., p. 23). Towards the end of the article, the author raises ethical issues of gendered robots and outlines:

In future research, there should be a focus on gender stereotypes, cultural influences, and robotic applications in various fields. At the same time, it should be considered whether gendering of robots for given roles is truly necessary to encourage interactions between humans and robots. (Nomura, 2017, p. 23)

While seeing the potential in utilizing gender stereotypes in robotics for enhancing acceptance of users, the author also reflects on whether gendering is “truly necessary”. He points to ethical issues, such as the reinforcement of gender stereotypes through gendered robots.

2.1.1 An Abstract Portrayal and a Tangible Alternative

It appears that a lot of literature and research deals with gender aspects in human-robotinteraction. As described earlier, it mostly deals with differences in acceptance of “male” and “female” robots, whatever this should mean, or the acceptance of “males” and “females” of robots. These words are put in quotation marks to show, first, the degree of absurdity when saying that a robot is male or female, and second, that the literature works, for the most parts, within a gender binary.

In this section, I will describe what these setups typically look like and then critically reflect on them. To be blunt, researchers often form two to three groups for robots or at least “male”, “female”, and sometimes gender neutral voices. The robots then per- formdifferent tasks, which are also sometimes assigned a specific gendered connotation. After the robot’s performance, it is evaluated as to which scenario the robot appeared “more competent” or was more accepted. Sometimes these experiments reproduce gen- der stereotypes, sometimes they don’t, but in most cases it ends at that point, without much reflection.

Besides the need for reflection on the results of the study, a proper reflection is neces- sary at the beginning, when the study setup is constructed. Reducing the test subjects to their sex or gender leads to an overemphasis on sex or gender differences, while many other parameters, such as age, socioeconomicstatus, experience, etc. might be neglected. Depending on the study, however, a further variable such as age might be taken into consideration, e.g. when doing studies concerning care robots. Döring (2013) queries if and how sex or gender should be sampled in questionnaires and takes Survey- and Measurement- as well as Gender- and Queer Theory into consideration.

Another topic, in my view, is the reflection on the results. I wonder, if gender stereo- types manifest themselves in the results, one could think ahead and break with these stereotypes rather than reproduce them.

2.1.2 Alternatives

Florian Dufour and C´eline Ehrwein Nihan (2016) in their article, “Do Robots Need to Be Stereotyped? Technical Characteristics as a Moderator of Gender Stereotyping”, tackle the question of whether robots need to be gendered, and therefore stereotyped in order to increase acceptance and the economic value of the machine. Instead of letting the “gendered look” or “fitting voice” suggest, what the robot is capable of doing, they decided to acknowledge technical characteristics in order to anchor the judgment of the users.

Although, the authors claim that further research is needed, their preliminary find- ings showed that “the effect of human stereotypes on the judgments of robots is not inevitable” (ibid., p. 8), since participants also evaluate the robot by the given technical characteristics. With their research, they strive for “giving designers of robots the choice between building stereotyped robots and building robots that avoid the perpetuation of human stereotypes, without impacting their potential economic value” (ibid. p. 8).

2.1.3 Gender Studies in HRI

The work of Yan Wang and James Young (2014) focuses on the differences in the in- teraction of women versus men towards robots, or further differences in the perspective towards robots. The authors raise the issue, that there is an underrepresentation of women in science and engineering, and in addition, women are partly overlooked as participants in HRI studies. This often leads to over-simplifications and dichotomies, when it comes to outlining the respective attitudes. Wang and Young advocate a higher gender sensitivity in order to achieve more highly nuanced results, in contrast to the “common ‘pink’ versus ‘blue’ simplifications” (ibid., p. 1).

In 2015, Rea, Wang and Young performed a further study dealing with gender in HRI, testing if they could replicate or falsify stereotypes that resulted from other studies. This worked out partly, while the stereotype that male participants are ruder towards robots than female participants held true, other stereotypes such as lower engagement of women with robots/technologies and their lack of a relaxed manner were disproven. However, their sample size was rather small and factors beside the participants’ gender were com- pletely neglected.

2.2 Robots in/and Society

Scholars from several fields, such as Cultural Studies, Studies of Technology and Society, Anthropology, History of Science, and Gender Studies, deal with the issue of robotics from a feminist or gender-sensitive perspective. Literature dealing with the topic theo- retically, as well as empirical research could be found.

2.2.1 Learning from Reviews

Starting off with a quote from the movie Her, Alesich and Rigby (2017) aim to un- derstand the implications of gendered robots for “our humanoid future”. Although the effect of the gendered robots cannot yet be observed due to the lack of an actual “roll- out of robots”, the authors argue that “assigning gender to robots will challenge and transform social and cultural

understandings of gender" (ibid., p. 50). They first out- line that "Gendering humanoid robots will also change our social and cultural ideas of gender in human bodies." (ibid, p. 58) This assignment of gender to robots, they argue, promotes the idea that "gender is an assignation, a set of attributes" (ibid.). Since the gender of a robot can eventually be changed fairly easy, the authors conclude that "we may start to question why human gender is fixed. This would challenge dominant social norms about the immutability of human gender, which could lead to a greater fluidity of gender, as argued by cyberfeminists" (ibid.). While this is certainly an interesting idea, it is a slightly techno-deteriminist one, which might need to be reflected on more thoroughly.

Anne Cranny-Francis's (2016) article gives a more nuanced overview of the issue of stereotyped and gendered social robots. She highlights the complex entanglements re- sulting from intimacy in human-robot interaction from a Gender Studies perspective. Intimacy, however, is not only an issue for humanoid social robots, as Cranny-Francis nicely shows with the case of Roomba, the vacuum cleaning robot, as studied by Maja Mataric. Mataric found that families owning a Roomba tend to have it repaired rather than replaced, since Roomba becomes part of the family somehow. In addition to prob- lematic aspects of this intimacy, this case would also be interesting in terms of thinking about repair versus discard.

2.2.2 Peeking into Japan

An early and very comprehensive study was done by Jennifer Robertson in Japanese robotic laboratories. The anthropologist and art historian, who is also a former director of programs on Japanese Studies and Science and Technology Studies as well as professor of Women's Studies, went to Japan to understand how the Japanese culture is entan- gled with robots, she thereby also raises gender(ed) issues. For her research, Robertson went to different robotics laboratories in Japan to talk to the mostly (99 percent as she describes it) male roboticists. Most of her work is clearly situated in Japanese cul- ture, however, it yields interesting insights for a "Western robot future" - to use the terms of popular media and policy makers. But before sketching out the generalities, I want to describe some specificities holding true for the Japanese context. In her article "Robo Sapiens Japanicus: Humanoid Robots and the Posthuman Family" Robertson (2007) investigates how "robot technologies are being deployed to reify old or 'tradi- tional' values, such as the patriarchal extended family and socio-political conservatism" (ibid., p.369). The robotic industry in Japan serves as an especially interesting exam- ple, since (humanoid) robots are deployed not only in huge factories but in the service- and (public) care sectors as well as for unpaid reproductive labor, for example in the domestic sphere. Back in 2007, Japan accounted for almost 52 percent of the global share of operable robots and was/is facing societal as well as demographic challenges, as it is framed. Birthrates are continuously sinking and the society is aging. Women are portrayed as less likely to engage in marriage and stay at home. The question arises, who will look after the senior citizens in the future? Since Japan has a rather restricted immigration policy and a low acceptance, which seems also rooted in Japan's history, the technological deterministic solution of these problems are robots, as shown by Jennifer Robertson. Looking to and writing about other parts of the world, cultures, etc., often holds the risk of normative assumptions or stigmatization. The author, however, situates the issue at hand very carefully within the broader historical, philosophical, pop-cultural and societal contexts. This was done by referring to Nishida Kitaro on the one hand, who is seen as the founder of modern Japanese philosophy and his theory of Ba (which "encompasses a non-dualistic concrete logic meant to overcome the inadequacy of the subject-object distinction" (ibid., p. 379)) and on the other hand, Shinto, as described in her latter article "Gendering Humanoid Robots: Robo-Sexism in Japan" (Robertson, 2010).

Shinto is described by Robertson as follows:

> The native animistic beliefs about life and death. It differs from the three major monotheisms (that have never had a home in Japan) in that it lacks compex metaphysical and theological theories. Shinto is primary concerned with notions of purity and pollution. Vital energies or forces called kami are present in all aspects of the world and universe; some kami are cosmic and others infuse trees, streams, rocks, insects, animals and humans, as well as human creations, such as dolls, cars and robots. (Robertson, 2010, p. 12, emphasis in original).

Shinto is often said to be the reason for the high acceptance of (humanoid) robots in Japan, besides the long history of pop-cultural phenomena, such as the so-called Astroboy. But where can we find the various gendered aspects in Robertsons work? First of all, it should be seen as problematic that the aspirations of bringing humanoid robots into the households are not to be deliberated from the gendered connotations of reproductive labor in the household but in order to make the traditional family model more attractive to women, and thereby encourage them to embrace marriage. The household robot is therefore seen as a support for women. The traditional household, as described by Robertson, consists of three generations living together, in contrast to a typical nuclear family. An illustrative example of how the future should look is a comic done in order to promote the Innovation 25, a “visionary blueprint for remaking Japanese society by 2025” (Robertson, 2007, p. 169), portraying the Inobe Family (cf. ibid, p. 387ff) - a “traditional” Japanese family with a robot that is able to perform household chores and take care of the children and is seen as a member of the family. The mother, who is portrayed as having the closest relationship to the robot, should not be freed from household chores so that she can do whatever she wants, but to be more prone to getting pregnant and serving as a “birthing machine” (ibid., p. 388).

Robertson’s article “Gendering Humanoid Robots: Robo-Sexism in Japan” (2010), as mentioned earlier, deals with further aspects worthy of looking at from a gender perspective. Her initial research questions are “How do robots embody ideas and notions of the relationship in humans between sex, gender and sexuality; and how do (the mostly male) roboticists design and attribute the female or male gender of humanoid robots?” (ibid., p. 2) In short, her answer would be that what the primarily male roboticists “take for granted in their own gendered socialization and quotidian lives is reproduced and reified in the robots they design and in their publications.” (ibid., p. 4) This can then lead to creating or moreover even sustaining “the facticity of their own world” (ibid. p. 4). Robertson therefore misses reflection as well as critical thinking, in order to not reinforce gender stereotypes in a posthuman sexism. An example forhumanoid gendered robots is the work of Ishiguro, who built robotic clones. He started with a replica of his daughter, who got scared of her “clone”, then built a robotic clone of himself and further tried to build a replicate of “the average Japanese women”, who was implemented with a high pitched voice and dressed in an “I <3 Hello Kitty” shirt and a black mini-skirt. While robots were initially designed gender neutral or male, design trends have now moved to female robots which are often referred to as “fembots”. “Tomotaka Takahashi, a leading robot designer and founder of Robo Garage, predicts that over half all future humanoids will be female.” (ibid., p. 18f) And this although roboticists had “technical difficulties” in building female robots, since they claimed that the servo motor needs to be interiorized and the body should be more slender than in a male robot. These assumptions about what a “female” robot needs to look like, and the “struggles” roboti- cists had to face in building one are intriguing, since it says a lot about the imaginations of what a (female) robot has to look like.

Robertson also brought up tensions, such as when human interaction is needed and when a robot is sufficient and for which tasks. While roboticists build robots for care- work, which is deemed highly social at least in Western countries, Robertson was derided when asking about the automation of the job of the so-called “elevator girl” or other receptionists following rather mechanical conversational patterns.

2.2.3 Grasping a “Mechanical Gender”

Roger Andre Søraa (2017) a scholar working in a department of interdisciplinary studies of culture and center for technology and society tried to introduce a ”mechanical gender” in contrast to biological (often declared as sex) and psychological (often declared as gender). In this case, the author proposes to add the mechanical gender to the critically regarded (e.g. Judith Butler) dichotomy of sex and gender. Therewith, the “mechanical gender” is reserved for technological artifacts, such as robots, and moreover for cyborgs. In his articles he sheds light on the issue of the proposed mechanical gender from various angles, such as linguistic acts, (non-)gendered humanoid robots, sex robots, zoomorphic robots, and the assumptions of users and designers. The linkbetween the “gender” of the robot and the “talking about the robot” becomes prevalent in some of the presented cases, e.g., in zoomorphic robots and in the users. Names are often loaded with meanings, in everyday life many people would claim that a name raises expecta- tions about the gender of the person (or animal) in question. The same became visible with zoomorphic robots, such as PARO or AIBO, without being equipped with gendered features, their name lead to gendering them and giving them pronouns such as he and she. Søraa also highlighted linguistic discrepancies in different languages, e.g., English, Japanese and German. While personal pronouns are very frequently used in languages such as English (you, he, she, it...) and German, this is not the case in Japanese. The author presents the following example as illustration:

> Whilst this may work for a while, it would sound strange to Western ears to say: “Pepper is home now, and Pepper is reading a book to ASIMO. ASIMO is enjoying Pepper’s tale.” Normally, one would replace names with pronouns. A second option would be to use gendered pronouns such as “he” or “she”: “Pepper is home now. She is reading a book to ASIMO. He is enjoying her tale.“ This puts the speaker in the position of having to choose the gender of said robots. There are ways to overcome this, though, with genderless pronouns, such as “it”, which would make the robot more of a thing than a being, but effectively would save the speaker from having to gender it: “Pepper is home now, it is reading a book”. (Søraa, 2017, p. 104)

The author also points out, that when asking the Japanese roboticists about the gender of a certain robot, e.g. Pepper, they would often answer, that any gender is fine. This also resulted in a variation of outfits for the robot, from dress to suit. While staying with “it” appears as a useful position for now, things get difficult when robots are so clearly gendered as Sophia[13] or sex robots, such as Harmony[14]. However, Søraa also problematizes the “Tabula-rasa state”

[13] Sophia is a robot created by Hanson Robotics, modeled partly after Audrey Hepburn and Hanson’s wife. (https://www.hansonrobotics.com/) It gained popularity due to its human-like appearance and was present a lot in the media, since it received the Saudi Arabian citizenship (as a marketing gag) (Reynolds, 2018).

[14] Harmony is a “sexrobot” from realdoll. I used quotation marks, because in the case of realdolls, sexrobot means that they have bodies of sexdolls, while they have attachable heads equipped with an AI, capable of conversation controlled via a smartphone application

(ibid. p. 103). Which means that sometimes robots are claimed to be designed to not fulfill any gender stereotypes, to be designed "neutral". Nevertheless, and this seems in line with Robertson, they can't get rid of their hidden assumptions and projections towards the designed robots.

The author explains, that the way we gender robots will most probably affect their "personality" (ibid., p. 111) and their area of usage. He also wonders, if they should be gendered at all, which is also contemplated by Londa Schiebinger (2018).

2.2.4 Gendering and Degendering Robots: Potential "Solutions"

Londa Schiebinger (2018) explains that robots are designed in a world, where gender norms, gender identities and gender relation are predominant. I would also argue that the whole depate about sex robots would look different in a non-patriarchal society, but since this is not about to change too quickly, this is the context in which those discussions must be held. As mentioned earlier, e.g. when talking about Søraa (2017), humans tend to gender machines and Schiebinger reminds us that gender and class are primary social categories (in social science research, for example). Nevertheless, she sstates a warning that "as soon as gender is assigned, stereotypes follow" (ibid., p. 18) yielding an amplification of stereotypes.

To deal with the situation, Schiebinger raises the following challenge for designers:

> The challenge for designers is: 1) to understand how gender becomes em- bodied in robots; 2) to design robots that promote social equality. Robots provide new opportunities to create more equitable gender norms. How can we best design both efficient and sociallyresponsible robots? (ibid., p. 19)

My question[15] would then be, whether they would do it, and how? Or better, why? So Londa Schiebinger looked at how gender is embodied in robots. Partly based on the robot Pepper, she formulated five criteria that appear to assign gender to robots.

> **Voice**: For Schiebinger, voice is the primary signifier of gender. She claims, that "voices are full of cultural information" (ibid., p. 19), depending of the pitch one might recognize the voice as male, female or child. While, a lower voice may signify more authority in Western countries, a childish voice is perceived as less threatening. Therefore, depending on the case, a different voice might be implemented into the robot, yielding different sets of stereotypes.

> **Name**: This category appears partly self-descriptive, however leaves some room for discussion. In the case of Pepper, Schiebinger argues that it is "nicely non- gendered" (ibid. p. 19). Additionally, the relation of name to voice might also play an interesting role, since this could break with stereotypes. Furthermore, name is a good example for something which is "put onto" a person, when thinking about directive speech acts.

> **Anatomy**: In the case of humanoid robots, features can be found that are used to givetherobot a male or female appearance. Schiebingerfinds Pepper confusingdue to its

[15] Parts of this chapter overlap with an essay done in the Seminar Philosophy of Technology and Performance held by Mark Coeckelbergh at the University of Vienna in the winter term 2018

bold head, clinched waist and skirt-like legs. However, shortly after Pepper was put on the market, an online store popped up, selling clothes, wigs and sticker make-up for the robot. While, there were clothes for all genders, interestingly butler-like clothing sold the best. This is interesting since it suggests something about the relations between humans and robots, moreover, the power-relations.

Color: "Researchers have shown that a few gender 'cues', lead people to assign gender to a robot. One human-robot interaction group found that a man's black hat or woman's pink earmuffs were enough for users to perceive a robot as male or female. Interestingly, when no cues were present, users tend to perceive the robot as male (maybe because in many languages, German for example, the word 'Roboter' is masculine; Western culture has a masculine default. Color is also an issue for ethnicity. Most robots - plastic or otherwise - are white, which places the robot culturally." (Schiebinger, 2018, p. 19f)

Character: Robots can be programmed to be polite and playful, such as Pepper, or to be "sassy and demure" (ibid.) such as Siri. Since human "harassment" towards those virtual assistants emerged, developers made Siri's answers more assertive and less polite when being insulted. This is important, since how humans treat machines might influence how humans treat each other.

Londa Schiebinger highlights, that "Gender assignment triggers gender stereotypes and evokes expectations for robot-human interactions." (ibid., p. 21) Therefore, Schiebinger promotes **six options for reaching a greater gender equality in robots** (ibid., p. 58):

1. **Challenge current gender stereotypes**: An example for this is Valkyrie, a rescue robot built by engineers at NASA. While robots in this field (security, rescue) are often gendered "masculine", as described in the respective section, Valkyrie is intentionally gendered "feminine". The designer claims, that he wanted to inspire his seven-year-old daughter.
2. **Design customizable robots, where users choose features**: Here, Schiebinger, mainly highlights robots that aside from being customizable, are able to be am- biguous due to a potential mix of gender cues. (e.g. Savioke's Botlr)
3. **Design "genderless" robots**: When sticking with humanoid robots, this is rather complex, since humans often try to assign a gender to things, that are human-like.
   Studies suggest, that robots without gender cues are often imagined male. (Søraa, 2017)
4. **Design gender fluid robots**: Schiebinger explains that there haven't been ex- periments on this yet, at least none that she has heard of.
5. **Step out of human social relations**: Avoiding human stereotypes seems most feasible when the robots are not humanoid, such as RIBA-II, which looks like a giant Teddy Bear.
6. **Design "robot specific" identities**, that bypass social stereotypes

While these options are sound, the realization is difficult, not only due to the economic drawbacks for the companies, but also due to hidden assumptions of designers and users, for example, as outlined by Robertson (2010). Additionally, as presented in Søraa (2017), we could think about just calling robots "it" no matter how humanoid they are shaped.

2.2.5 Example: The Genderless Voice

One example that nicely illustrates Schiebinger's third point is **"Q"**[16], a genderless voice, which is created "to end gender bias in AI assistants". The reason the researchers made "Q" was to offer an alternative to the often gendered technologies, since they reinforce and perpetuate a "binary perception of gender".

This example appears especially tangible, since voice assistants, such as Siri, Cortana and Alexa are already part of our everyday lives.

3 Use Cases

3.1 Care Robots

A vast amount of literature can be found in the domain of care robots, however, mostly not directly from a gender or feminist perspective. Reasons for highlighting this field in the context of this work can be conceptualized from at least two aspects. First, care work still has gendered connotations. The implementation of care robots will thus affect women, in particular.

Second, when imagining care robots in old-age homes, the residents dealing with robots are more likely to be women, since a higher percentage of women are admitted to such homes (McCann, Donnelly, & OReilly, 2012). Nevertheless, from an intersectional feminist standpoint, it is necessary to also highlight the perspective of the care receivers independent of their gender identity.

However, especially the many ways in which (emotional) care is handled as unpaid labour, makes the issue an inherently feminist one. Topics raised in literature are the care-reciprocal, meaning that care needs to be something symmetrical, furthermore, deception and a discourse about supplementing versus substituting care workers. Also participatory technology development seems interesting in this case, when negotiating who is regarded as an expert. Who is asked and who gets left out in the design process of care-related robots?

Jennifer Parks (2010) looks at the case of care robots from a feminist perspective focusing on the often exploited care workers. For her, care is first a political issue and then a moral one, and although she deems the perspective of the care recipients to be important, she focuses on the care workers in her article. Whereas she does not appear strongly averse to care-robots in the beginning, she becomes more critical towards the end. Cases she deals with are located in Japan, Germany and the US, where major cultural differences can be observed.

Moreover, she highlights more general concerns related to care, which can be observed today as well, such as cost-cutting, decreasing care-ratios and shortage of caregivers. While she expresses her hopes, that "the cost-cutting that automation offers could lend itself to improved social interactions" (ibid., p. 115), she worries that technological solutions will not yield improvement with regard to increasing social isolation.

Important aspects to consider when building care robots would be to create an in- frastructure, that highlights the needs and demands of people who are confronted or might be confronted with robots in the care sector. A value-sensitive design, which means including ethics in the design process, and promoting "the fundamental values in care" (van Wynsberghe, 2013, p. 408) as suggested by Aimee van Wynsberghe, could be a good basis for this. She thus also promotes interdisciplinary collaborations among diverse researchers. Here, the question could

[16] https://www.genderlessvoice.com/

be raised as to whether a transdisciplinary approach involving caregivers might be even more advantageous.

3.2 Robots in the Domestic Sphere

When looking at Roomba, the vacuum cleaning robot, it is undeniable that robots have found their place in the domestic sphere. This opens up feminist questions but also questions regarding gender, which are obviously not that new, since the domestic sphere has always been one of feminism's battlefields. The question about gender-codedness of technologies has already been dealt with by Judy Wajcman in 1991. Wajcman is an important scholar in feminist sociology of technology who also worked on technologies in the domestic sphere. The main arguments of her work are that despite the enhancement of domestic technologies, no liberation of women in the domestic sphere has been achieved. Instead of having more leisure time, (hygiene) standards were raised and not much has changed. She presents three categories of unpaid work (ibid, p.93): "rou- tine domestic chores (cooking, cleaning, other regular housework), shopping and related travel, and childcare (caring for and playing with children)", it is conceivable that all of these could be done by robots in the near future. Now the question arises as to whether her arguments will still hold for domestic robots, or if robots disrupt the continuity. Nev- ertheless, taking Judy Wajcman's thoughts into consideration appears productive when it comes to thinking about, but also developing domestic robots. Similar to Haraway's promise that technology is emancipatory, this first advancement in home automation did not bring relief, and it is not self-evident when looking at Robertson's report on the "Inobe family" that the liberation of housework by robots will take place.

Fortunati (2018) deals with the topic from a materialist feminist perspective several years after Wajcman, at a time when robots started to become reality, and answers the question, why there has been a shift of robotization from "the factory" to the domestic sphere. While, the domestic sphere had the reputation of being "backwards" it is now the place of innovation, Fortunati argues. "White goods" (domestic appliances) became more interesting than "Brown goods" (consumer electronics). Furthermore, Fortunati tries to shed light on the attitudes of people towards robotization and finds that in contrast to the 2014 Eurobarometer (a public opinion survey performed by the European comission), pupils in her sample could indeed imagine robots in the domestic sphere, including domestic use, care and education.

3.3 Sex Robots

Concerning the topic of sex robots, at least two different perspectives can be found. Kathleen Richardson (2015) takes up an abolitionist feminist approach, and dooms sex robots by analyzing their risks and furthermore initiates a campaign against sex robots. She criticizes the commodification of women's and childrens' bodies, and condemns sex- ual exploitation of women and children. The link between prostitution and sex robots comes from the chess player and AI researcher Levy, who highlighted this ostensible analogy. Both are problematic from Richardson's perspective. For her, sex needs the symmetrical component and can't exists in the asymmetry, which is the case in robot "sex" but also in prostitution/sex-work. She also rejects the argument, that an imple- mentation of sex robots would decrease the number of women exploited in sex work, since the percentage of men taking advantage of prostitution has increased, although the sex industry increased as well. Moreover, together with others participating in the Campaign against Sex Robots she believes, that these robots in the form of women or children might potentially be harmful and increase societal inequalities.

Tanja Kubes from the Technical University in Munich, just recently turned her re- search focus to robots and more specifically sex robots. In a workshop unit called "Let there be pleasure! Gender-Queer Perspectives on Sex Robots and Robot Sex", she presented her approach to dealing with sex robots from a gender-queer perspective, highlighting the emancipatory potential of queer pleasure-bots. Similar to Richardson, she critiques the human-like model, which is far from representing diversity and takes stereotypes to the extremes. However, she does not reject sex robots completely, but argues for more diversity and "queerness" in sex robots meaning that the robots don't have to resemble humans, but that they could "transcend the humanoid limits". In her talk this was accentuated with a bright and colorful image of sex toys of different shapes and colors.

Questions that could be raised in this context include the implications of such hyper- gendered fembots on sexuality. How consent plays a role in the debate around sex robots; and what emancipatory potential is present in imagining "queer" sex robots?

3.4 Masculinities and Robots

In the course of this review, we have seen how robots are gendered and why. In many cases, "female" robots seemed prevalent, after the engineering of a slender shape was fig- ured out. However, there is one field where the "gender-of-choice" seems to be masculine: security robots and the like.

Heather M. Roff's (2016) work deals with the gender performance of robots built for dangerous environments. Based on the "Robotics Challenge" of the United States De- fense Advanced Project Agency, also known as DARPA, she tackles the issue of warbots, or more correctly "rescue robots" from a gender perspective. The initial point of her paper is the evaluation of the presented robots with respect to their potential gender. Thereby, Roff looks at the "gendering-processes" of the robots built for the DARPA challenge.

One issue that appears evident in this field is the reproduction of "hegemonic mas- culinity". Roff argues, "The humanoid robot fighter is the ideal of masculinity in western culture, for it represents an 'independent, risk-taking, aggressive, heterosexual and rational' being free from any weakness, particularly irrationality, frailty, emotion or desires." (ibid., p. 2) Furthermore, in her article, she outlines three potential aspects through which the construction of gender can take place, namely: "hardware", "naming", and "software". (ibid., p. 2) The third aspect, the software, focuses strongly on machine learning and AI and falls thereby in the field of critical algorithm studies, with an em- phasis on gender bias. The hardware as well as the naming aspect are strongly in line with discussions found in the area of "gendered robots", as described in the respective chapter of this review. As outlined, her empirical case is the DARPA Robotics Challenge where the majority of robots in the contest were humanoid, and many of them gendered, mostly masculine. Cues for their gender were either the hardware or the name and rep- resentation of the robot. Valkyrie, a robot with "breasts" - which are said to serve as a place for the batteries, yielding a more preferable center of mass for their aims, posing with "one hand on hip, one arm effortlessly hanging to one side with the fingers relaxed. Its shoulders are not squared, but one droops slightly more than the other" (ibid., p. 6) contrasts its "male" opponents, such as Atlas, Hercules, Helios, Thor and Florian.

As mentioned at the beginning of chapter 3, HRI studies often try to evaluate, the tasks for which a robot should be made as gendered. Masculine robots "score well" in tasks surrounding security (cf. Tay, Jung & Park, 2014). Trust also plays a major role in HRI studies, Gallimore

et al. (2019) present a “RoboCop” via video to their participants, to evaluate its trustworthiness. Although, the robot does not have many gender cues, it is declared to be male. Although, the gender of the robot is mentioned in the limitation of the studies, the authors do not reflect upon potential negative implications of such a gendering. While, in many cases “female” robots were preferred (educational settings, domestic settings, care settings, sex robots), war bots, and security robots, tend to be gendered “masculine” if they are gendered at all.

4 Conclusion

The aim of this report has been to make readers more sensitive to the need to integrate a gender(ed) perspective on research in robotics and human-robot-interaction. By intro- ducing examples of gendered and genderless robots and howgender is already integrated in research, my aim was to motivate readers to question their own assumptions about the “mechanical gender” or gender more generally.

Furthermore, it appears that the current discourse on robots is characterized by high expectations. Spectacular announcements of new prototypes usually turn out to be presentations of minimal progress. Instead of autonomously acting robots, very often remotecontrolled artifacts are presented. Japan’s immigration laws have been eased, to counter the lack of care workers, rather than allow the employment of care robots. This might prove to be a stroke of luck. Slow progress allows for more reflection and demo- craticdiscourse on issues such as: **Where do we want to encounter robots; Should they be humanoid and why? or in which cases? Why they should or should not be gendered and what implications this gendering process might have; and what it means when a study shows that a feminine/masculine/gender neutral robot is more accepted?**

The literature presented hints at examples and analyses related to the topic, in more and sometimes less abstract ways. Obviously, it is not easy to find a “recipe”, an “algorithm” or a “panacea” for creating robots in a gender-sensitive or non-binary way. However, Londa Schiebinger (2018) offered a helpful set of possibilities for doing so. **Why not challenge current stereotypes and create a genderless or genderfluid robot?**

Haraway’s (1991) promise of emancipation and liberation in a post-gender world are presented when discussing sensitizing concepts. One last question could explore **how technologies/robots need to be designed to enable a deliberating and eman- cipatory futures.**

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