SLU

(Not) Representing Cycling

Exploring the subjugation and multiplicity of cycling

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Abstract

Cycling is often represented as a symbol of sustainable mobility change. This thesis builds on the argument that even in acclaimed cycling cities possibilities for cycling to become part of transformative change are stifled. The research this thesis grounds in sees dominant discourses in research and planning to reproduce conceptions of cycling to 'fix' mobility, without troubling the fundamental unsustainability of current patterns of production and consumption inherent in automobility. This is shown through practices of representation and how they tend to perpetuate narrow constructions of cycling as a rational, efficient, urban mode of transport for the responsible utility cyclist. While these constructions problematise motoring and indeed might make cities more livable and 'greener', they subjugate imaginaries of what else cycling could be and for whom. Vélomobility imaginaries, non-representational theories and de-growth scholarship are employed to analyse how representations are constructed and with what effects on envisioning mobility systems. This is shown by analysing how cycling is 'represented' in three contexts: sustainable transitions research, municipal planning in Uppsala, Sweden, and a local bike repair initiative.

   The thesis argues that representations are essential to how cycling is governed and should therefore be taken seriously. Recognising representational implications is a pre-step to recovering, reclaiming and nurturing alternatives. Pluralities of cycling are important to overcome narrow cycling conceptions and change the meaning of cycling in society. This thesis suggests that cycling representations can be understood as multiple when thought of in dimensions that recast representations as both discursive constructions and embodied practice performances. Cycling then becomes an arrangement of multiple cycling practices, a diversity of people and bodies, material elements to support cycling and different cycling technologies and spaces for cycling. Applied to the three cases, the thesis shows how cycling might be conceived of through these dimensions and how they reflect in vélomobility characteristics engendering commoning, care, autonomy conviviality, or to maintain mobility status quos. The thesis thereby adds to critical mobilities scholarship and vélomoblities in particular.

Keywords: cycling, representation, non-representational theories, mobility fix, mobility transformations, performative ontologies, vélomobility, degrowth, materialities

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Abstract

Cykling representeras ofta som en symbol för en hållbar mobilitetsförändring. Denna avhandling bygger på argumentet att även i hyllade cykelstäder kvävs ofta möjligheterna för cykling att bli en del av en transformativ förändring. Forskningen som denna avhandling bygger på menar att dominerande diskurser inom forskning och planering tenderar att reproducerar föreställningar om cykling som en "fix" för mobilitet, men utan att problematisera den fundamentala ohållbarheten i nuvarande produktions- och konsumtionsmönster som är inhysta i automobiliteten. Detta påvisas genom representationspraktiker och hur de tenderar att upprätthålla snäva konstruktioner av cykling som ett rationellt, effektivt, urbant transportsätt för den ansvarsfulla nyttocyklisten. Även om dessa konstruktioner problematiserar bilismen och faktiskt kan göra städer mindre motoriserade och "grönare", tenderar de att förtrycka de föreställningar om vad cykling annars skulle kunna vara och för vem det är till för. Vélomobility-imaginaries, icke-representationsteorier och de-growthperspektiv används här för att analysera hur representationer konstrueras och vilka effekter dessa representationer har på före-ställningar om mobilitetssystem. Detta visas genom att analysera representationer av cykling i tre olika sammanhang: forskning om hållbara omställningar, kommunal planering i Uppsalastad och ett lokalt cykel-reparationsinitiativ.

Avhandlingen argumenterar för att representationer är avgörande för hur cykling styrs och möjliggörs och därför bör tas på allvar. Att synliggöra innebörden av representationella konsekvenser är ett första steg till att återvinna, återta och vårda alternativa föreställningar. En bredare syn på cykling är viktigt för att överkomma snäva cykelföreställningar och möjliggöra en förändring av innebörden av cykling i samhället. Denna avhandling argumenterar för att cykelrepresentationer kan förstås som multipla när de betraktas i dimensioner som omformar representationer till både diskursiva konstruktioner och förkroppsligande praktiker. Cykling blir då ett fenomen innehållandes flera olika cykelpraktiker, en mångfald av människor och kroppar, materiella element vilka möjliggör cykling och olika cykeltekniker samt platser i tid och rum för cykling. Tillämpat på de tre olika sammanhangen visar avhandlingen hur cykling kan uppfattas genom dessa dimensioner och hur de reflekteras i vélomobility-perspektiv som ger upphov till gemensamhet, omsorg och autonomi, eller för att upprätthålla ett status quo för synen på rörlighet. Avhandlingen bidrar därmed till forskning inom kritisk mobilitetsvetenskap och vélomoblities i synnerhet.

Sökord: cykling, representation, icke-representationsteorier, mobilitetsfix, mobilitets-transformationer, performativa ontologier, vélomobilitet, de-growth, materialiteter

Preface

Notes on the dust cover.

Designed by the brilliant Jan Schablitzki, the dust cover shows a collage of AI-generated images prompted by terms revolving around the thesis topics, such as cycling, (bi)cycle, movement, space, cycle repair, cyclists, governance etc. Jan and I used craiyon.com and stablediffusionweb.com to generate the images (see the back of the title page for more information).

With a thesis on the (non)representation of cycling, I thought it apt to let AI visually 'represent' cycling. It problematizes representation as a visual domain that reproduces 'reality', to things, people and practices as more than representational thought; topics I seek to explore in this thesis. AI has been criticised at times to not generate new imaginary but to recombine fragments of existing depictions. To me, criticism becomes an allegory for the (im)possibility of creating something imaginary, like cycling futures. The cover is therefore also a representation of the struggle of process, the way of getting somewhere that does not yet exist.

Prompting the collage images made me furthermore aware of certain patterns. Despite varying prompts and styles, elements of cycling, particularly people cycling, cycles and cycling futures, are depicted similarly. Renderings of people cycling I mostly read as male bodies. Cycles are, when not explicitly prompted to look different, *bi*cycles with a diamond frame. (Urban) cycling futures were depicted as gloomy, dystopian scenarios. These cycling imaginaries are mixed with the alternative, 'out-there' ideas of what cycling might be represented as. This exploration shows in wild combinations of search terms in an attempt to tease out something different than dystopian cycling futures. You will find combinations of prompts to represent different bodies cycling, vélomachines, cycling space and cycle-other-than-human relations.

Reflective of the disconnect between the way cycling is commonly represented and the way it might be, this thesis is an exploration of the in-between, between cycling's subjugation and multiplicity.

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To the family in Söderköping: Johanna, Manuel, Eleonora, Valentin and Gabriel. Your home is a great place to escape. Thank you to the families in the south-west for the encouragement and opportunities to recharge. Jan, besides Joana, you've experienced my academic ventures the closest. Thank you for always being there when I needed to vent, and for your great advice and impeccable design taste. My family in the west: Karin, thanks for inspiring me to not give up. Simon, big brother, for holding the fort. I've learned a lot from you. Burghard and Heike, I would never have been able to study for so many years without you. Thank you for persevering and that no matter what strange ideas I have for life, you believe it will work out somehow. You help me not to drift off too much and bring me back down. Thanks for life advice during weekly phone calls and that even though I'm no longer young, you're still Mama and Papa.

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I would need at least five volumes to put into words what you mean to me. You have picked me up more times than I can remember. You are a role model for life in and outside of work. I wish I could only support you a fraction of the way in your doctoral studies you support me in mine. I love you. Quantum mechanics.

Contents

List of publications

This thesis is based on the work contained in the following papers, referred to by Roman numerals in the text:

I.   Valentini, D., Wangel, J. & Holmgren, S. (2023). Representations of urban cycling in sustainability transitions research: a review. *Eur. Transp. Res. Rev.*, 15, 28. https://doi.org/10.1186/s12544-023-00603-3.

II.   Valentini, D. & Holmgren, S. (2024). (Manuscript) Means of knowing cycling and planning for success — cycling governmentalities in Uppsala. In preparation for submission to the special issue in Cycling and Micromobility Research "Critical Tensions in Planning for Cycling".

III.   Valentini, D. & Butler, A. (2023) Bike Kitchens and the sociomateriality of practice change: exploring cycling-repair relations. *Urban, Planning and Transport Research*, 11:1, DOI: 10.1080/21650020.2023.2259235.

Papers I-II are reproduced with the permission of the publishers.

The contribution of Daniel Valentini to the papers included in this thesis was as follows:

I.   I developed the research design, conducted the analysis and synthesis and wrote the paper. Josefin Wangel contributed to developing the introduction, methodology and provided comments and revisions on draft versions of the paper. Sara Holmgren contributed to developing the introduction, presentation of results, discussion and provided comments and revisions on draft versions of the paper.

II.   I developed the research design, collected the material, conducted the analysis and wrote the paper. Sara contributed with comments on all parts of the manuscript.

III.   I developed the research design, collected the material, conducted the analysis and wrote the paper. Andrew Butler commented on and suggested revisions to the manuscript.

List of tables

Abbreviations

ECF	European Cyclists' Federation
NRTs	Non-representational theories
PEP	Pan-European Masterplan for Cycling Promotion
SPTs	Social Practice Theories
UNRIC	United Nations Regional Information Centre for Western Europe
WHO	World Health Organisation

1. Introduction

Cycling offers well-acknowledged benefits compared to motorized individual transport. It enhances physical activity on an individual level and offers societal health benefits (de Hartog et al. 2010; Gerrad et al. 2012). Cycling is almost emission-free (Massink 2011) and contributes to safer, more attractive and liveable cities also for people not (yet) cycling (Buehler & Pucher 2021; Gössling 2020; Massink 2011). Numerous studies on the subject of cycling open with similar statements on its advantages, and a list of multiple co-benefits could be extended. But the message would be similar: due to its benefits, cycling is worth nurturing (PEP 2021).

Awareness of cycling's benefits is for instance reflected inter-nationally, where cycling is listed as a key contributor to several Sustainable Development Goals (WHO 2022). Attention to cycling also finds reflection in national transport strategies, plans and programmes, dominantly in the global north-west, and Europe in particular (ECF 2020). This is also the context in which this research was conducted and resonates closest with. Cycling as a development tool has become established in political and policy discourse. Further fortifying its discursive position are the hopes attached to cycling for mobility transitions and transformations in times of multi-crises (UNRIC 2023; cf. Sheller 2018).

A broad knowledge base is accessible to effectively translate ambitions into policy and implement them in local contexts. From street over network level designs to "policy, strategy and program level development" (Parkin 2022:112), best-practice guidelines are available to direct decision-makers and planners towards developing more cycling-inclusive spaces. This is to a point where the technical measures to advance cycling for transport are at times claimed to be known (e.g. Schlossenberg 2022). Yet, there is a notable gap between the discursive support for cycling, the accumulated knowledge

on planning and urban design interventions for cycling, and its implementation (cf. Banister & Hickman 2013; Whitelegg 2020; von Schneidemesser et al. 2020). This implementation gap, or paradox, provides the first problem space that this thesis investigates. However, the research this thesis builds on identifies the implementation gap as merely a symptom rendered visible by attempts to use cycling as a 'fix' for the underlying problems of systemic automobility and paradigms of growth (Spinney 2021, 2022). Manderscheid & Cass (2023) make this point in relation to mobility and transport more generally:

> In the case of mobilities and transport, the most pressing problem at hand seems to be CO2 emissions and their reduction […]. Sustainable transition and climate protection becomes a problem to be solved by increasing energy efficiency, new fuels, better infrastructures and electric drives. The questions that lie behind — which society, which city or which world do we want to live in, which regime of accumulation and consumption fits best with ecological and social sustainability and how and how far do we want to move goods and ourselves in future […]?— disappear. (Manderscheid & Cass 2023:11)

Under these scenarios, cycling becomes a solution to the wrong problem or an answer to the wrong questions. Carol Bacchi famously posits that we are governed through problematizations (2012), meaning that policies don't address problems 'out there', but bring them into existence to make them governable. Cycling becomes a solution to the problem of air pollution, short-distance car journeys, struggles for urban space, and sedentarism (Spinney 2021; Koglin 2020). What these problematisations fail to acknowledge is that these 'fixes' operate under the assumption that emission and growth can be decoupled, by innovative, cleaner technologies, or the good old bicycle to replace car trips. They fail to acknowledge that the car is not the problem, but an outcrop of systemic automobility (Cox 2023a; Spinney 2021; Urry 2004).

Automobility as a system is pervasive because of the interlocking elements that evolved around it and create dependence upon it (Manderscheid & Cass 2018; see also Cox 2023a). Institutional discourses on mobility as reflected in policy, reproduce rather than challenge the hegemony of automobility (Urry 2004). Automobility becomes continuously reproduced, not only in policy, but as the normalised cognitive societal frame to conceive of,

and hence act on, mobility (Caimotto 2020; Manderscheid 2014). Auto-mobility has been positioned alongside subversive neoliberal governmental-ities, notions of productivity, efficiency and a modernist planning rationality that affect the way *cycling* is constructed, governed and planned for (Popan 2019; Koglin 2020; Koglin & Rye 2014).

To utilise cycling as a fix, it also needs to be represented in a certain way. Pro-cycling policies, research and public discourses contribute to these representations when positioning cycling as a healthy, sustainable, rational and efficient mode of urban transport (Spinney 2021, 2022). Cycling is not one thing, there are endless 'cyclings' (Cox 2022:20), but few prevailing conceptions of cycling (e.g. Spinney 2021; Aldred et al. 2016). Dominant governance modes operationalise narrow range of cycling representations to treat the symptoms of urban mobility problems (van der Meulen & Mukhtar-Landgren 2021), rarely addressing the underlying 'problems' of mobility.

In light of these problems, it is important to render visible the systemic entanglements, but also to envision and propagate equitable alternatives. By example of cycling, this thesis seeks to contribute to both challenges.

There is a need for new mobility imaginaries (te Brömmelstroet et al. 2022), ways of envisioning cycling's role in mobility futures that are sensitive to the previously described problem layers and that recast mobility problems as problems of automobility and growth. To engender new imagi-naries, I argue in this thesis, means identifying and challenging dominant conceptions of cycling that go beyond utilizing cycling as a mobility fix. To overcome this subjugation, cycling representations ought to be more diverse. This includes paying attention to its multiple dimensions, or elements. To transform mobility, its meaning needs to change (Adey et al. 2023). This includes rethinking mobility assumptions and finding new ways of imagining mobility futures in light of degrowth (Cox 2023a).

In this thesis, the concept of representation helps me to identify the processes underlying representation; representational practices. I bring these into conversation with the concept of vélomobilities (e.g. Cox 2019, 2023a; Koglin 2013) as degrowth compatible, imaginary, mobility configurations. This allows me to utilise representations and vélomobilities as a critical lens to scrutinise the effects of cycling representations, but also as a generative tool for envisioning multiple alternative conceptions of cycling.

The argument is substantiated by empirical analysis of how cycling is represented in three contexts: sustainability transitions research, municipal

cycling governance in Uppsala, Sweden, and a local cycle repair initiative. I argue through the three studies on which the thesis is built, processes reproducing dominant or challenging dominant representations of cycling, can be better understood. The first two tell stories of representational subjugation, reproducing narrow conceptions of cycling as mobility fixes, the third is an active exploration of alternative cycling representations in light of degrowth characteristics. Yet, both positive and negative lessons for mobility transformation can be derived from all three cases.

This thesis contributes to critical micromobilities scholarship, particularly the branch of vélomobility studies, with nuanced analyses of cycling representations and their effects on corporeal mobilities in light of vélomobility imaginaries (cf. Urry 2002; Sheller & Urry 2006). Although based on empirical studies, the main contribution is theoretical, by drawing together different theories and concepts to bolster the conceptualization of vélomobilities. This thesis offers a re-engagement with the concept of representation taking critiques of 'representationalism' into account (cf. Simpson 2020:134). This is done by focusing on the practices of representation which allow linkage to practice performances, such as cycling and cycle repair as forms of representation under a performative ontology. I use the notions of representations and representational practices in this thesis to signal the co-production, or co-construction, of different 'cyclings' through discursive (language) practices and practice performances.

The identified problems in this chapter lead me to an aim and three research questions driving this thesis and presented in the following chapter.

1.1 Aim and research questions

The aim of this thesis is (1) to render visible the systemic entanglements that make cycling a mobility fix, and (2) to envision mobility change inspired by vélomobility imaginaries.

Three research questions help me to meet the thesis aims:

I. How (a) and as what objects of governance (b) is cycling constructed in different contexts?

The three papers underlying this thesis reflect the three different contexts of research, municipal governance and a local bike repair initiative. The question

addresses in research, municipal cycling governance, and a local cycling-supporting initiative. RQ Ia asks about the 'how', the modalities and practices of constructing cycling as governable objects. 'Objects' here mean constructions of cycling as governable entities and does not presume a material focus. The pluralisation to 'objects' indicates that constructions may be multiple. Identifying these objects is the focus of RQ Ib. To answer both questions under RQ I, I develop a 'framework' to analyse cycling constructions as representations. I distinguish between discursive (language) representations and embodied forms of representation. In the discursive, the constitutive role of language is brought to the fore. The embodied forms of representation foreground the experiential aspects of cycling as practices in relation to materiality, space and events. The two forms of representation are co-constituting, where language affects experiences and vice-versa. Such an understanding of cycling then allows analysing the effects of representational cycling constructions, which is the subject of RQ II.

II. What are the implications of these constructions on cycling's anticipated role in mobility systems?

This question investigates to which extend the constructions of cycling identified under RQ Ib contribute to perpetuating dominant mobility conceptualisations, or challenge them. To answer this question, I turn to Peter Cox (2023a) for a comparison between characteristics exhibited by systems of automobility compared to imaginary vélomobility systems. Drawing on degrowth and post-growth literature and critical mobilities studies, I add characteristics that help to further sensitise vélomobility towards commoning, care, autonomy and conviviality. This then allows me to answer RQ III:

III. Based on RQs I & II, what lessons can be derived for working towards Vélomobility futures?

1.2   Thesis structure

This is a compilation thesis, meaning that it builds on three individual papers (Paper I–III) attached at the end of the thesis. The papers are stand-alone and make their own respective contributions. As part of this dissertation, they act as empirical material to support the claims made throughout this work. That is, each paper presents a different context in which cycling is constructed

through representations in different ways. Jointly, they help to substantiate how representations construct different versions of cycling and with what effects.

After having introduced the problems underlying this thesis in the first chapter, and presented the aim and research questions in the second, the remainder of the text is structured by six additional chapters.

In the next chapter I present the research background and the empirical context of this study in individual chapters. The thesis, including the three papers, takes inspiration from scholarship on governance, systemic understandings of urban cycling, and vélomobilities as imaginary mobility arrangements. Because papers II & III relate to the context of Uppsala, the empirical background chapter describes the governance of cycling in Sweden in the realm of planning (see also Paper II), presents selected characteristics of cycling in Uppsala, and introduces the Ultuna Bike Kitchen on which study three is based.

Thereafter I turn to the theoretical core of the thesis. Here I introduce conceptual notions not articulated in the three papers, but drawn together for the purpose of this thesis. The here developed notion of representation helps me outline cycling's multiplicity and identify its subjugation. The chapter seeks to bring together ideas from critical policy studies, Cultural Geography, Science and Technology Studies, vélomobility and degrowth under the umbrella of performative ontologies.

Chapter four presents the methodology, as the strategy that guided the thesis and the respective papers, its materials and methods. It closes with a short reflection on my positionality and explains the inevitable changes in the research designs throughout the thesis project.

Chapter five then turns to the empirical. Here I summarise the three papers and relate their findings to the thesis questions. Chapter six revisits the research questions and answers them by applying the notion of representation developed in the theory chapter to the insights gained from the papers. It is here that I support the claim of dominant representations subjugating alternatives and that developing plural alternatives requires deliberate and conscious effort.

Finally, in chapter seven, I draw some overarching conclusions and point towards potential future research avenues based on the gained insights.

2. Background

This chapter positions my PhD-work in a scholarly and empirical context. Chapter 2.1. begins by outlining broad notions of governance, urban cycling systems and vélomobilities as a common thread throughout the three papers and this thesis. Thereafter, in chapter 2.2, as a backdrop to Paper II & III, I briefly describe the context of cycling and cycling governance in Sweden, Uppsala and introduce the Ultuna Bike Kitchen as a research site.

2.1 Research background

2.1.1 Governance

In this thesis, governance perspectives are recognised as means to "study the complex processes through which a plethora of public and private actors interact to define problems, set goals, design solutions and implement them in practice" (Sørensen & Torfing 2018:350). I understand the governance of cycling as the practices through which different actors come together to construct, act on and for issues of cycling. This encompasses the ways in which cycling is constructed as a governable object, is made amendable to deliberate interventions as well as the technologies and practices through which governance is enacted. Such a broad definition of governance is useful for this thesis, because it allows me to capture governance on a spectrum of different modes, from hierarchical to diffused notions of network governance. I see planning practices as a part of the wider governance landscape (Boelens 2021) that is important for the municipal governance of cycling in a Swedish context (cf. Koglin 2013).

Governance has been researched through different theoretical lenses and applied to various empirical contexts. In this thesis I don't employ a particular theoretical perspective, since it concerns the subject of governance and less the different theoretical approaches to governance. Instead, I take an interpretative approach that aligns with a reading of governance as an everchanging, contingent process, where agencies and structures are a product of social relations (Hillier 2017; Rose & Miller 1992; Boelens 2021). The individual papers in this thesis align with this broad description of governance, but differ in the level of empirical and analytical emphasis.

Paper I underlies a co-constitutive understanding of governance, where we foreground how researchers construct cycling as governable objects in

studies interested in fundament change processes (Paper I). Paper II is more explicit in its governance focus and is a retroductive analysis of cycling documents to uncover the governance of cycling in Uppsala as a process of advanced liberal governmentality. Paper III is interested in the wider actor network of cycling governance and how a local Bike Kitchen might relate to the cycling governance networks (Paper III).

The three papers foreground different dimensions of cycling and actors in the governance of cycling. They are conjoined in that they seek to better understanding cycling's current and potential role in fundamentally transforming mobility systems.

2.1.2   Systems and urban cycling

Cycling is entangled with, and stands in relation to, other practices, material and immaterial elements and dimensions. The complexity of cycling's interwoven relations has been conceptualised in terms of, for instance, assemblages (e.g. Lea et al. 2022), regimes (e.g. Schwanen 2015), discourses (e.g. Van der Meulen & Mukhtar-Landgren 2021; Caimotto 2020), or social practices (e.g. Larsen 2017b; Spotswood et al. 2015). The perspectives forground relationality, co-constitution and socio-materiality in different ways.

The three studies in this thesis reflect ideas of systemic relations within and between systems derived from different scholarly traditions. I understand their commonalities in simultaneously paying attention to the sociality, materiality and practices of cycling. Their common genealogy may be traced back to reorientations found at the intersections of different turns in the Social Sciences and Humanities, including notions of Science and Technology Studies (STS) after the turn to technology (Woolgar 1991) (Paper I), problematisation of discourse (Paper II), practice (Cetina et al. 2005) (Paper III), mobilities (Sheller & Urry 2006) (all papers and this thesis) and ontologies.

Conceiving of governance as the deliberate management of change carries different implications under different systems conceptualisation. This doctoral project started with a close orientation at sustainability transitions as a research object (Paper I) and then ventured to conceive of systemic change as breaking discursive patterns (Paper II) and dynamics in social practices (Paper III). Sustainability transitions primed me to consider cycling

systemically, as socio-material and in light of radical system change towards low-carbon transport systems.

Sustainability transitions are fundamental transformational processes in which societal systems shift towards constellations enabling more 'sustainable' modes of production and consumption (Köhler et al. 2019). These processes often take decades and much of the early transitions research has tended to retracing systemic shifts in societal subsystems, such as transport and mobility. Transitions research unfolds at the intersection of the natural sciences, social sciences and humanities drawn together by innovation studies and STS. It proliferated over the last 20 years into an amalgam of different theoretical models, analytical foci, underlying theoretical tenets and assumptions. Köhler et al. (2019:4) explain how the foundational frameworks underlying transitions studies "all take a systemic perspective to capture co-evolutionary complexity and key phenomena such as path-dependency, emergence and non-linear dynamics." Some authors cluster transitions studies' broad scope around three dominant approaches to the study of societal systems: socio-technical, socio-ecological and socio-institutional (Loorbach et al. 2016).

I take inspirations from a systemic understanding of societal systems that are co-constituted by relations between heterogenous elements, forming arrangements dynamically-stable patterns along transitions pathways that pose significant challenges to purposeful steering towards more sustainable configurations (Avelino & Grin 2017; Turnheim et al. 2015). A challenge in researching complex systems is whether research ought to reduce it or articulate its messiness (Köhler et al. 2019). Transitions research leans towards articulating complexity in detailed case studies (ibid.). In a similar vein, Paper II and III depart in Uppsala and seek to articulate complexity in municipal institutional practices (Paper II) and alternative cycling-supporting arrangements (Paper III) respectively.

Much of my thinking about cycling in this thesis underlies research that addresses cycling as an urban phenomenon[1]. This focus is most dominant in Paper I, where transitions studies on urban systems (Torrens et al. 2021) at the intersection to governance (Bulkeley & Stripple 2021) provide inspiration. Cities are the main arenas for cycling promotion, with cycling being

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[1] I acknowledge that the delineation between 'urban' and 'rural' (e.g., Scott et al. 2007) can be problematic and has also been addressed in cycling research (e.g. Brezina et al. 2022). and employ the two terms with reference to the published literature under investigation in Paper I and the terminology employed in public cycling documents (Paper II).

arguably one of the most "sustainable" forms of urban mobility (Pucher & Buehler 2012, 2017). With resource consumption and carbon emissions aggregating in and around cities, cycling and cities are often brought together as a sustainability match. The generalised 'urban' becomes an essential ground for fundamental mobility change (Torrens et al. 2021).

With reference to mobility studies, transitions literature has shown how carbon-intensive mobilities are still an essential part of everyday lives (Sheller & Urry 2006; Niolaeva et al. 2019; Abey et al. 2022). Systems around high-carbon mobilities form the real-world context where transitions studies and much of critical mobility studies intersect. In Paper I, I don't question a city framing of cycling. Instead, I looked at transitions and cycling as a relevant research avenue that embrace systems' complexity as generative for systemic mobility change, where cycling offers a governance direction without being too prescriptive for multiple possible mobility futures that are inherently less consumption focused and more just. There has so far been little engagement with cycling from transitions perspectives (e.g., Bruno 2022; Paper I).

2.1.3   Vélomobilities

Vélomobility is a concept that carries various implications for my research, which I will outline in this chapter. As a body of literature, I position it within critical mobilities scholarship and interpret the notion of vélomobility to offer three characteristics that make it relevant for this thesis. First, vélo-mobility offers a critical lens to investigate how cycling is conceived of and governed in a systemic and relational understanding as outlined above and second, it provides a means to conceive of alternative mobility system characteristics taking this criticism into account. Third, vélomobility addresses mobility systems' entanglement with growth paradigms.

Vélomobility does not only demarcate a "cyclist's form of mobility and, as the term suggests, refers to mobility on a bicycle" (Koglin 2013:65), but is a critique of systems of automobility as well as the political and economic paradigms that manifest it. As a deliberate juxtaposition to automobility (Cox 2023a; Koglin 2013, 2015), the outlines of vélomobility become clearer in relation to (auto)mobilities.

Vélomobility derives from mobilities thinking that is inherently relational and systemic. Peter Cox (2023a:1) describes vélomobility as a response to automobility, where "automobility refers not just to the practices of travel by car, but

to the mobility systems comprised of numerous elements (spatial and temporal) and dimensions (political, economic, social and discursive) in which motoring is entangled and from which the motor car cannot be separated (Featherstone, Thrift and Urry 2005; Böhm et al. 2006; Geels 2005)."

Movement in a mobility understanding is constitutive of social life and (im)mobile subjects. Mobilities research gains critical characteristics by engaging with questions of "inequality, domination, and constraint" (Söderström et al. 2013, p.13); the reciprocity between power and mobility. John Urry and Mimi Sheller were among the first to outline the links between power, dominance and mobility in describing the system of automobility in detail (Urry 2004; Sheller & Urry 2006). The network of dependencies that developed around automobility over time make the hegemony of motorised transport as well as its resilience to change apparent (Urry 2004). At the same time is automobility in vélomobilities understanding coupled to societal patterns of consumption and economic growth that increasingly exceed planetary boundaries (Rockström et al. 2023; Meadows et al. 1972).

Vélomobilities sensitise this thesis to see how, for instance, cycling research (Cox 2023a), politics, policy, planning practices (Cass et al. 2018) or activist interventions (Cox 2023b) may perpetuate the negative effects of growth imaginaries. It has for example been argued that cycling and cycling-promoting interventions grounded in an understanding that the negative externalities of carbon-based modes of mobility represent a 'problem' that cycling can 'solve' (cf. Bacchi & Goodwin 2016; Bonham and Bacchi 2017). Research has evidenced that 'promoting' cycling may lead to incremental modal shifts in favour of cycling.Yet, these solutionist approaches often fail to recognise that car use is only an expression (the tip of the iceberg) of automobility. These approaches don't address automobilities hegemonic position and wider entanglements with political economies, and paradigms of movement (Cox 2022a). Critical cycling research has for example outlined how mobility is embedded in an economic growth paradigm and capitalist systems of accumulation (e.g. Spinney 2021). Such research uncovers how cycling, when implanted into current mobility systems becomes a 'fix' to automobility´s externalities that perpetuates rather than challenges economic systems argued to be a root cause of contemporary multi-crises (Sheller 2018; Adey et al. 2023). Cycling as a mobility fix often narrows cycling to a gendered utility mode and urban form of transport (ibid). Attitudes of fixing

mobility therefore constrain the transformative potential cycling might inspire (Furness 2007, Cox 2023a).

In addition to pointing out flaws in mobility thinking and practices, vélomobility can be a tool to imagine alternative mobility futures.

> "Consequently, authors such as Koglin (2013) have adopted vélomobility as a term to explore the parameters and possibilities of a system of mobility predicated not on private motoring but on human scaled mobilities based on active travel forms (see Chapter 21)." (Cox 2022:21)

Vélomobility becomes "a response to seeing the problem not as one of needing more efficient cities but as one of automobility as a key driver of carbon capitalism" (Cox 2023 personal communication). Peter Cox proposed characteristics that mobilities systems in a vélomobility understanding might display (Cox 2023a; table 1).

Table 1. Comparisons between systems of automobility and vélomobility after Cox (2023a)

Automobility	Vélomobility
Closed, self-reinforcing, path-dependent, excludes users and uses	**Open-ended, malleable, escaping foreclosure and emphasising multiplicity of possible system arrangements**
Pragmatist, solutionist approaches to governance	**Utopian, imaginary and reflexive**
Technology and innovation-driven	**Doesn't rule out technological innovations as part of open-source commons**
Exclusionary hegemonic system of movement and being	**Vélomobilism — as a reimagined mobility — is characterised by its multiple elements (people, things, practices, spaces) and meanings that must not be restricted, but need to be nurtured to evade dominance of any one system arrangement.**
	System elements need careful re-examination to the extent to which they create foreclosure and of alternatives and might lead to marginalization of alternative arrangements
Deterministic and co-evolutionary	**Reflexivity to evade system foreclosure**

Compared to automobility, vélomobility emphasises the embodied dimensions of mobility as well as the representations of cycling (Cox 2023a).

Cycling is not only the act of cycling, as a performance involving a cycling subject and some form of cycle, but its entanglement with space and social processes (Cox 2019). The cycle emerges here not as a neutral material entity or artefact, but as a vehicle of and for change (Cox 2019; see also Popan 2019). Vélomobilities are "mobility practices structured around human-powered wheeled mobility" (Cox 2019:4). Or as Furness (2007:299) notes, "vélomobility [is positioned] within a paradigm of utopian urbanism" (see also Cox 2019:29).

The position developed here reflects my thoughts on cycling's utopian roles in mobility at the time of writing this cover letter that slightly deviates from how I relate to vélomobilities in the three papers. Paper I is least reflective of a vélomobility approach. Drawing on transition studies it shares vélomobilities concern with fundamental systems change but is at odds with the vélomobility's systemic charcteristics outlined above. For example, transitions tendency to emphasise structuration over emergence, co-evolutionary competition between technologies and practices and eventual hegemony and singularity over open-endedness, plurality and co-existance. In Paper II, vélomobility becomes an analytical lens for scrutinizing cycling representations and their subjugating effects in government practices. Paper III is an attempt to explore the generative (utopian) dimensions of vélo-mobility as a way of enacting how it could be otherwise (cf. Popan 2019).

2.2 Empirical context

Contextual grounding is important to understand governance processes and their underlying problematisation (Bacchi 2012). While cycling practices can be understood as spatially and temporally unbound entities, their enactment and hence their meaning can only be grasped in their context of performace (Cox 2019; Shove et al., 2012; Scheurenbrand et al. 2018). Two studies in this thesis concern the empirical context of Uppsala that is already explained in Paper II & III respectively. Here I want to briefly draw together aspects relating to cycling planning and governance as an empirical background to position the two studies. The aim here is further contextualization not a detailed description. Three aspects guide this description: (1) the institutional nesting and key role of municipalities in governing cycling through (spatial) planning in Sweden. (2) The role of advocacy coalitions and networks

around cycling governance. (3) The role of urban cultures, topography and morphology for cycling.

2.2.1 Cycling and planning in Sweden

Whitelegg (2020) argues that Sweden's Vision Zero marks paradigm shift for integrated transport policies. Instead of focusing on individuals behavior and modal separation to increase traffic safety, the ethical baseline ought to be no person dying, or getting seriously injured in traffic. Vision Zero is transformational, Whitelegg argues, in that it cuts through various policy areas. However, despite the potential for transcending paradigms (cf. Whitelegg 2020), when looking at cycling specifically, Vision Zero does not automatically diffuse into local cycling policies and cycling-supporting interventions in swedish municipalities (cf. Isaksson 2014).

Cycling is Sweden, as in other countries, is anchored in the realm of spatial planning (Spinney 2021; Anaya-Boig, 2021). Swedish municipalities are autonomous in planning for their land-use, transportation and thereby matters of cycling. They are responsible for 80% of the more than 24.0000km of the Swedish cycling network (Trafikverket 2021, 2020). The state and the counties (regions) are responsible for about 15% of the national and regional cycling network. The remaining 5% are private actors' responsibility (Trafikverket 2021). The municipal planning monopoly is challenged when cycling is to extend beyond the municipal, or even city boundaries and requires inter-municipal coordination. It is one of the challenges Uppsala describes as a barrier to advance 'rural' cycling (see also Paper II). Furthermore, positioning cycling as a matter of spatial planning problematizes the use of space for mobility entwined with questions concerning physical cycling infrastructures and therefore politics and power.

In Sweden, Koglin (2020) observes a frequent mismatch between planning ambitions, visions and implementation reality. For instance, the construction of cycling infrastructure, Koglin argues, is embedded in wider political ambitions that are often disparate if not contradicting (ibid.). Koglin and Cox (2020) dedicated an entire volume to the 'politics of cycling infrastructure', where the contributors describe and analyse the inevitable politisation of cycling infrastructure and how cycling is consistently marginalised in policy, planning and space. Koglin and Rye (2014) see a paradigm of instrumental rationality affecting planning ideals and practices in Sweden. Developed in the 1950s to promote automobility, these rationalities are still

reflected in Swedish cycling planning today and considered a key driver for cycling's marginalisation in policy and planning (Koglin & Rye 2014). Automotive power, Koglin argues, became materialized in road infrastructure and therefore a component in automobilities hegemonic dominance (Koglin 2020).

2.2.2 Cycling in Uppsala

Uppsala's two Universities affect cycling in the city. Uppsala, located 70km north of Stockholm, is Sweden's fourth largest city with about 234,000 inhabitants, more than 10% of which are University students and almost 8.000 people working at a University (Uppsala Kommun 2021). The city has a compact urban centre with most inhabitants living within a 5km radius.

About one third of all trips within the city are by bike, but can reach up to 40% in student neighbourhoods (Uppsala Kommun 2016). The large student population, a moderately flat topography and short distances are often accredited with supporting a high cycling mode share. The municipality describes the cycle-path network as well-developed (557km as of 2022, of which 80% in the city) and speaks of a strong cycling culture (e.g., Uppsala Kommun 2013, 2023). In recent years, the municipality has increased its efforts to advance cycling further (Uppsala Kommun 2021; see also Paper II). While not extensively researched in a Swedish context, Koglin (2022) has observed a similar tendency in Lund, where the urban structure and Lund's University have a pronounced influence on cycling levels.

As part of their active networking practices, Uppsala Municipality communicates their cycling-related efforts within and beyond the municipality on social media and the municipal websites. Cycling-relevant information such as the annual cycling accounts and the public documents framing municipal cycling work are collated at the municipality's website. The documents found there provide much of the empirical basis for Paper II to which I also refer for more information.

2.2.3 Cycling governance in Uppsala

Developing safe and comprehensive cycling networks is essential for increased cycling and among the key demands of cycling advocacies, activists, and individual citizens, in Sweden (Balkmar 2020; Emanuel 2012,

as well as other countries (Cox 2023b). The importance of infrastructure provisions is also acknowledged by Uppsala municipality (Uppsala Kommun 2017a). However, planning ambitions have to face the fiscal realities, where matters of cycling are often not a political priority and hamper municipalities capacity to support cycling (Alm & Koglin 2022). Infrastructure interventions, especially mode-separating cycle path designs, are found to be most desirable from cyclists' perspectives (Christ et al. 2023), but are also more costly than behaviour interventions. From a municipal perspective, we observe in Paper II an emphasis on less costly behavioural interventions to responsibilise citizens for their roles in cycling governance (see also Hysing 2021; Spinney 2018). We further find that despite a lesser emphasis on new infrastructure development, maintenance, management and upgrades to the existing cycling network are foregrounded (Paper II). For instance, in 2022 Uppsala spent 44% (25.2 MSEK) of the annual municipal cycling budget for the cycle path network on seasonal maintenance alone (63% for maintenance overall) (Uppsala Kommun 2023).

Balkmar (2020) observes that cycling advocacy organizations in Sweden have long had considerable influence on cycling politics and policy (Emanuel 2020, 2012). Uppsala Kommun actively seeks collaborations with several actor groups to improve cycling, make it safer and more attractive in different ways (Uppsala Kommun 2022). In Paper II we show that municipal cycling planning in Uppsala depended on the inclusion of wider actor networks to render cycling governable as part of an advanced liberal cycling network. We further illustrate how actor coalitions have been instrumental to evaluate cycling-supporting interventions. The national cycling advocacy Cykelfrämjandet was particularly influential as their assessment of cycling promoting measure was (1) reflected in Uppsala municipality's approach to cycling promotion and (2) helped to consolidate Uppsala's status as an active cycling-promoting municipality.

2.2.4 The Ultuna Bike Kitchen

Even in cycling cultures such as Copenhagen, a high cycling mode share does not imply people maintain their bikes regularly (Larsen 2017b). A similar observation in Uppsala led to establishing a Bike Kitchen at SLU (see also Paper III). The Ultuna[2] Bike Kitchen (Cykelköket Ultuna) is a bike

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[2] Ultuna, in the southern part of Uppsala city, is where SLU's main campus is located.

repair initiative. I established in 2019 through funding from the University's flight carbon offset scheme (Klimatfonden). Besides the practical relevance and my own interest in Bike Kitchen volunteering, an underlying ambition was to explore the concept's economic, organizational and operational flexibility. The budget was therefore conservatively projected to 61.000 SEK[3], with the largest share set aside for cycle-specific tools and a stock of 'consumables'(such as puncture repair kits, oil, grease, cleaning products, etc). General (not cycling-specific) equipment, such as furniture or used spare parts were donated or sourced second-hand. Part of the budget was invested into a portable tool set that is now available for anyone at the central reception and information desk.

The climate fund application required outreach and collaboration with internal and external partners. Particularly Akademiska Hus (campus facility and property owner) and the Department of Urban and Rural Development at SLU were and still are instrumental for the project's realization. Akademiska Hus provides the workshop space for a nominal rent, which is in turn covered by the Department of Urban and Rural Development. With workshop space and rental cost accounted for, a common challenge for Bike Kitchens could be avoided (Persson 2019; see also Paper III).

Volunteer recruitment and management is another bottleneck affecting Bike Kitchens' longevity. After initial attempts to recruit volunteers, I quickly decided to operate the Bike Kitchen independently. This does not rule out volunteering opportunities. Whenever visitors express an interest in helping out, I encourage and appreciate their efforts. However, making volunteering an obligation we found at times to have a negative effect on regular engagement and the enjoying participation (Paper III). Over time, several people took active roles in the Bike Kitchen, which was both a big help in assisting people with their repair queries and a great social support (cf. Bradley 2018; Batterbury & Manga 2022).

Since the first open workshop in September 2019, the organizational model therefore emerged over time and up until the point of writing, stabilized. The Bike Kitchen has regular opening hours once a week every Thursday between 16.00 and 18.00. Despite being a campus operation, the Bike Kitchen is not exclusive to University staff and student visitors, but open to everyone.

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[3] At the time of application 61.000 SEK converted to around 6.000€.

Pragmatism in the Kitchen operation also extends to managing the materials and parts available at the Bike Kitchen. Most of them are sourced through visitor donations, or from the local student housing association after their annual bike weed-out. Some bikes became part donors while other bikes where in good-enough condition to be repaired quickly. Five bicycles can now be borrowed for free, for instance for people with projects that cannot be completed within one workshop session, or for visiting staff and students that are in Uppsala short term and want to cycle.

This chapter provided both the scholarly and empirical background to my doctoral project. Next, a more in-depth description of theories and concepts sets the stage for developing an understanding of cycling representations that will later on be applied to the findings of the three papers (see chapter 6).

3. Theory

The chapter provides a unifying onto-epistemological ground for the thesis. Based on cycling scholarship, I then develop a conceptualisation of cycling as an intermingling of discourse, materialities and practice. The chapter ends with reflections on the applicability of such a framework in light of vélo-mobility-oriented mobility transformations through the notions of commoning, autonomy, conviviality, and care.

3.1 Outlines of a framework to analyse cycling representations

I orient much of my thinking about, and employment of, the term 'representation' at performative ontologies (e.g. Bacchi & Bonham 2014). This includes earlier elaborations on the conflation of epistemology and ontology to an ontological politics (Mol 1999, 2002), reflections on methods, and the role of science in constructing realities (Law 2004; Law & Urry 2004; Büscher & Urry 2009), policy studies (e.g. Bacchi & Bonham 2014, Savage et al. 2021), planning and governance (Gunder & Hillier 2016; Hillier 2017). Representation as part of the analytical framework is furthermore oriented at non-representational theories (NRTs[4]) originally developed in cultural geography (Thrift 2008; Anderson 2019; Simpson 2020). While heterogeneous, these bodies of literature share characteristics that render them commensurate and relevant for the thesis aim.

Commonalities include a practice focus (cycling, representational, planning, governing, discursive, research, methodological and their relations),

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[4] I will use non-representational theories and more-than representational theories interchangeably in an understanding that they both encompass the same perspectives as concerned with representational effects while differing in their terminology (cf. Simpson 2020).

enactments, performances, how they work (modalities) and what they do (effects). Embracing a practice focus entails decentring the human agent and a symmetry with materialities (e.g., cycles, cycling infrastructure, bodies and spaces). In foregrounding modalities of practices, the approaches pay attention to power not as a predisposition, but as a relational, contingent, situated and dynamic. In light of power, practice modalities and effects raise issues of knowledges (epistemics) and justice. Attention to knowledge-producing practices and their lived effects then raise questions about the nature of realities (ontologies), if and how these realities are knowable and what the implications of reality-knowledge-nexuses are. Knowledge about reality, in the performative ontology I invoke here, is inseparable from the realities it produces.

To make representations cut across these disciplines, I locate them in terms of practices of representation. A position that aligns with Cresswell's who argues that "an NRT take on representation has added a new liveliness to the way we think about representation as an act — a verb — rather than as a thing" (Cresswell 2012:99 see also Simpson 2022:22). Cresswell continues by outlining characteristics of representations:

> Geographers who wrote and write about representation […] were and are always trying to figure out how representation works in and with the world. The work of geographers informed by cultural Marxism, feminism, and poststructuralism was precisely about how meaning is unstable and unfixable, how power through representation is never complete, and how representation always works with practice and performance. (Cresswell 2012:99; see also Simpson 2022:22)

Through the framework I construct a notion of cycling representations as the relation between language, cycling practices, people cycling, materialities *for* and *of* cycling and spaces. I call these intermingled components 'dimensions' to signal their plurality and interconnectedness. With different combination of dimensions, different nuances of cycling can be foregrounded. Conflated, these dimensions in turn represent established themes in mobilities and cycling scholarship to conceptualise cycling (e.g. Cox 2019; Jensen 2011; cf. Norcliffe et al. 2022).

3.2 Discursive representations

This chapter focuses on the effects of representations and their underlying mechanisms. Representations are coupled to meaning (Hall 1997; Cox 2019) and commonly associated with discursive practices[5] that produce representations, mediated through language, texts and images (Simpson 2020; Bacchi & Bonham 2014). The focus on mechanisms and effects is important to note. Mechanisms I use to signal the focus on practices that produce, or construct, representations. Effects, because they position representations as inadvertently affecting the real world, such as mobility practices. I will elaborate on more-than representational approaches as addressing the blind spots of discursive representations in the next chapter with an emphasis on practice performances and their affectivity, the material and spatial. For now, I will start with 'language' as the first, discursive, representational dimension in the analytical framework.

Tim Cresswell (2006, 2010) identified representation (meaning) together with movement and practice as co-constitutive of mobility. In Cresswell's view, representations give movement a "shared meaning" (2010:10), "impact the experience of its practice" (2010:27) and together with the embodiment of movement affect transport planning. This implies that the way cycling is represented is important for the governance of cycling and cycling practices (Cox 2019; Spinney 2021).

To analyse representational processes and effects in government practices, Carol Bacchi (2012) also together with Susan Goodwin (2016), has tied representations to Foucault-inspired policy analyses. In this form of analysis, policies create problem representations (problematizations) that are necessary for government conduct. In order for government to function, society ought to be rendered governable through practices of knowledge production that separate the population, practices, objects, and spaces into governable entities (Bacchi & Goodwin 2016). In this understanding of representations, they produce subjects, objects and places (ibid.). Several studies have critically investigated the modalities and effects of representing cycling (e.g. Horton 2016; Cox 2019; Aldred 2016; Pedroso & Aldred 2023; Bonham & Johnsson 2015; Koglin & Mukhtar-Landgren 2021). For instance, Bonham

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[5] Though discourses in a Foucauldian reading go beyond the use of language (e.g. Bacchi & Bonham 2014), I will use discursive representations throughout the text focusing on language practices that can take the form of written and spoken words, imagery or even object (Cox 2019). It allows me to distinguish between language as a representational dimension and discursive representations to emphasise the focus on construction and effect.

& Johnson (2015:10) provide an illustrative example of the "cyclist" as a discursive construction in research with subjugating effects on policy:

> Borrowing from Mol (2002, p.117), the term 'cyclist' can be seen as a 'co-ordinating mechanism' that spans disciplinary boundaries and prevents the 'pluralising' of the bike-body assemblage into 'separate and unrelated objects', but each [research] discipline brings a different version of the cyclist into effect […]. Clearly, if objects (and subjects) do not precede these various networks of relations but are enacted within them, then objects (and subjects) are fundamentally political (Law & Singleton, 2014, p. 380). They are political in terms of both the forging of the strategic relations which produce each version of the object (and subject), and the version of reality […] which becomes prioritised in policy.
> (Bonham & Johnson 2015:10; see also Cox 2019:21)

Because representations create subject and object positions they also result in exclusion and oppression of entities not covered by certain representations (Cresswell 2006). Dominant representations inadvertently lead to marginalisation. What is outside a norm becomes the unspecified and subjugated other, a catch-all category for things, people and practices that don't quite fit templates of what is "normal" and therefore accepted. Cycling has become the 'other' to automobility (Cox 2023a). Infrastructural projects (Hoffmann 2016; Koglin 2020), bike sharing systems (BSS) (Smith et al. 2015) and 'soft' policy measures (Koglin & Rye 2014) frequently result in marginalization, often affecting groups of people already considered marginalized. What is good for the construction of middle-aged, affluent white male 'standard cyclist' has implications for the unrepresented other.

However, representational categories are not immutable, but relational and emergent in context. Effects of representations may be anticipated by what they do and do not represent (Law 2004). They may have constraining effects on the mobile subject, but they can be changed.

Two main reasons make a focus on the discursive effects of representations (texts, images, etc.) salient for this thesis. First, discursive approaches to study the governance of cycling are reflected in both Paper I, where we investigate researchers' construction of cycling, and Paper II on the governmentality of cycling in Uppsala. Second, for the thesis framework, the per-

formative approach to discursive representations allows me to integrate subjects, objects, spaces and practices as four dimensions in the representational cycling framework.

Where this chapter has looked at the effects of representations from the outside, as governance practices, the next chapter turns to the embodied, material and entangled dimensions of cycling practices beyond the discursive.

3.3   More than (discursive) representations

Non-representational theories (NRTs) emerged out of criticism towards a heavy reliance on texts and images in cultural geography (Thrift 2008). Or as Simpson comments on NRTs:

> Put succinctly, such non-representational thinking sought to re-orientate geographic analyses beyond what was, at the time, perceived as an over-emphasis on representations (images, texts, and so on) and instead emphasize practice, embodiment, materiality, and process. (Simpson 2020:4)

Because discursive representations are partial and make it difficult to capture the embodied and relational dimensions of practices and their constitutive materialities (spaces, bodies, objects) (Dewsbury 2002 see Simpson 2022:8f). In the way I position (discursive) representations together with NRTs in this thesis, I follow arguments brought forward by, for example, Paul Simpson (2022), Mitch Rose (2016) and Ben Andersson (2019). I use NRTs as complementary to discursive representations on cycling practices and their governance.

Where representations frame practices, objects and subjects from the outside (for examples through governing practices), NRTs look from the inside out. NRTs allow for explorations of practitioners embodied and affective involvement in practice arrangements that is obscured when approached as discursive alone (Simpson 2020). Post-structural discursive perspectives already see practices entangled with materialities, including bodies, objects, spaces and the practices they constitute (Bacchi & Bonham 2014). NRTs further emphasise the 'background', the relational, as emergent and practiced. Foucauldian discourse and governmentality studies have long overcome the criticism of being too focused on the structuring and constraining effects of discourses (e.g. Kerr 1999; Alvesson & Sköldberg 2000). NRTs

decentre representations even further and emphasise the embodied and emergent of practices that may challenge dominant representational practices (Cox & Koglin 2020). NRTs can speak less to the apparatus (dispositf) of government, but go beyond mechanisms and into practices and their meaning (see e.g. Lin & Spinney 2021 and Manderscheid 2014 utilising the dispositf in mobilities research). With these characteristics, NRTs bring nuance to the representational framework, particularly the previously introduced dimensions of practices, people/bodies, materialities and space.

Besides being complementary to discursive representations, NRTs allow a practice-orientation that also underlies Paper III. While not directly concerned with the practice of cycling, Paper III engages with change and emergence of meaning in repair and maintenance practices involving the materialities of cycling: cycles. In conjunction with Social Practice Theories (SPTs), NRTs further emphasise the performative potential of practice change in the governance for cycling that also Paper III addresses. SPT and NRT share further characteristics as correlates of their joint practice focus, of which relationality, embodiment, performance, affectivity and materiality might be most important to describe in constructing the representational framework.

Discursive representations affect the body as a site of "differentiating and disciplinary practices" (Simpson 2020:47), yet bodies perform practices. In turn, practices are perceived in relation to the body, including a wider range of the sensory system beyond the visual (kinesthetic, olfactory, auditory, tactile). It is through the body that we perceive our surrounding, but it is through practices that meanings transpire. "Or as Anderson and Harrison (2010a:6) put it, 'meanings and values emerge from practices and events in the world'" (Simpson 2020:47). Performances are central for NRTs and SPTs as it is through performing practices that meaning emerges, changes, or stabilise. In Paper III we use SPTs to investigate how meanings can arise, or change through cycle repair and maintenance practices.

The body is furthermore central to sensory experience, such as affect. Justin Spinney (2021:123) defines affect as: "how emotions, sensations, atmospheres and feelings arise out of relational encounters between objects, spaces and people (Thrift 2004; Anderson 2006)". Affect, as a relational bodily response to something happening, is central in the embodied dimensions of cycling practices (cf. Spinney 2021; Larsen 2017a). Affect foregrounds the contribution of spaces' and infrastructures' role in experiencing cycling.

Paper III approaches affect as moods and emotions, which may describe the elation after a successful repair, or the sense of accomplishment when enacting repair together.

NRTs and SPTs rebalance the importance of materiality, decenter the subject in studying practices and emphasize relationality. Materiality and a lack of material care is the starting point for the investigations in Paper III, where we distinguish between three types of materiality: infrastructure, tools and resources (cf. Shove 2017). We define infrastructure after Shove (2017) as something that forms a material backdrop to practices, but that is seldomly consciously related to, unless it does not function as expected. In an NRT and SPT understanding, the Bike Kitchen as an infrastructure becomes meaningful through the practices within it. For the analytical framework I expand the notion of infrastructure to materialities for cycling.

As material entitites, cycleways, road signs, cycle boxes, etc. play coordinating, facilitating or inhibiting roles for cycling. But the built infrastructure is also of central importance for cycling as it contributes to affect and meaning by making cycling more or less convenient, safe, secure, fast, frictionless or seamless (Cox & Koglin 2020; cf. Paper II). With the label materalities *for* cycling I want to go beyond the physical infrastructure and include other materialities that literally support cycling practices, such as cycle service stations or parking facilities. The idea here is not to provide a laundry list, but to sensitise for new ways of seeing cycling and cycling-supporting interventions as relational. Another reason to introduce materialities *for* cycling was to be able to distinguish it from the material dimension of cycles, or materiality *of* cycling. In Paper III we present the bike and the Bike Kitchen as semiotic objects that, as part of practices, are central to meaning making processes (Larkin 2013; Schatzki 2019; Gieryn 2000). Cycles can act as epistemic entities and make practices knowable in new ways, with implications for governance, governmentality (Shove et al. 2012) and the political (Larkin 2013).

Lastly, spaces are important in relations to practices, not only as coordinating entities of constraint, but as enacted, emergent and 'meaningful' (e.g. Latham & Wood 2017). Different spaces afford different cycling practices. The enactment of practices intersects with the spatio-temporal distribution of practice arrangements. How does cycling become habitualised, or driving disrupted, are practice-oriented questions of concern. For Paper III

this has implications for how repair and maintenance can be slotted into everyday activities, but also if spatial proximity to other sites of practice allows for repair in the Bike Kichen when the cycle cannot be used.

To conclude this chapter, NRTs together with SPT open for new ways of thinking and, more importantly, experiencing cycling. Embodied and experiential dimension of practices emerge in relation to objects and surroundings. NRTs and SPTs sensitise the representational notion of cycling in the framework. They also problematize normalized cycling planning and governance practices.

3.4 Framework summary

> In the midst of representational singularity there is multiplicity. (Law 2004:137)

Cycling, seeing someone cycling, seeing cycling depicted, and cycles, are single forms of representation, where this chapter seeks to develop the idea of multiplicity. Representation, as I aimed to position it in the previous chapter, goes beyond the linguistic in a representationist tradition, and may be broadened to incorporate more-than-representational notions. Discursive representation in this thesis takes inspiration from critical policy analysis as a tool to deconstruct often taken for granted assumptions in policy and governance not to address problems in the real world, but as constructing (representing) the problems they seek to address. Yet, where these approaches leverage at discursive practices to illuminate problematisations and coordinating mechanisms, I broadened the notion of representation to the embodied and experiential dimensions of practices, spaces and materiality.

Cycling performances and practices foreground certain cyclings while marginalising others. Cycling does something in us and with us, but it also means exposure to and interaction with, other people, things and landscapes (Cox 2019). People see us cycling (or using other forms of mobility) as we negotiate space with them. Cycling and space (or landscapes as outlined earlier) are interacted. Materiality features into the blend of cycling as physical infrastructure or the cycles themselves. These dimensions are essential to cycling, while representing cycling with all the ramifications of potential marginalization and othering. I see my proposal in line with a process ori-

ented notion of ontological politics, or the politics of knowledge; a framework to sensitise for seeing the plurality of cyclings (Valverde 2011; Scott 2020), or the lack thereof. To reflect on why this might be so, why cycling is in many places automobilities 'other', the framework is a tool for reflexivity and reflection (Alvesson & Sköldberg 2000).

Table 2 summarises the different cycling dimensions and relates them to examples of sensitizing questions to explore the effects of representational practices.

Table 2. Overview of cycling dimensions and sensitising questions exemplified

Cycling dimension	Discursive representation	More than discursive representation
Practices	Plural or singular? More than 'utility'?	How are the different dimensions experienced in relation when performed? How might discursive constructions affect more than discursive representations and vice-versa?
People and bodies	More than the 'standard' cyclist?	
Materialities *for*	More than cycle paths and lanes?	
Materialities *of*	More than the standard bicycle?	
Spaces	More than urban, spatially separated from other mobility?	

3.5 Ontological politics

Representations of reality imply the construction of subject and object positions which in turn foreground certain entities while marginalizing others. Othering is an inevitable result and raises ethical questions of how to account for the subjugating effects of representations (Mol 1999; Law 2004). One approach to handle the subjugation of others is to encourage a plurality of voices, for example in research and planning practices (e.g. Anaya-Boig 2021; Sheller 2020). Another is reflexivity in governance (e.g. Jessop 2003; Hillier 2017) and research (e.g. Orr & Bennette 2009; Alvesson & Sköldberg 2000).

Vélombility (Cox 2022), post-structural planning theorists (Hillier 2017) and Science and Technology scholars (Mol 1999; Law 2004) have identified openness, a focus on process, plurality, contestability and reflexivity as important systems characteristics (cf. Table 1). The flexibility of these recommendations reminds us that there is no silver bullet approach to governing towards vélomobility futures, but that decisions have to be made in context and will never be perfect. Ontological Politics therefore don't

provide solutions, but raise more questions to navigate the enactment of choices (Mol 1999). When epistemology and ontology become conflated, claims to truth can no longer be the only judge for decision-making (Law 2004). Ontological Politics outline a crucial yet crude operating space for decision-making; it sets boundaries, but does not proclaim new arbiters in addition to truth. John Law (2004), for example, suggests different goods that are enacted and may factor into the choice of realities, for instance the aesthetics, the spiritual, or justice.

As Mitch Rose (2016) suggests, navigating the pluriversal is a political act that requires representation, *because* it requires choice (cf. Mol 1999). It is therefore necessary for the aim of this thesis to sketch out some more detailed context and derive some decision-supporting indicators that align with vélomobility characteristics for mobility systems and capture the representational, as well as the non-representational dimensions of cycling. I turn to degrowth and post-growth literature to outline these characteristics.

3.6 Outlines for vélomobility characteristics

I previously argued that vélomobilities scholarship sees the narrative push for more cycling as a response to the problems of automobility systems. Vélomobility identifies the common problem in which both utilitarian cycling, cycling-promoting efforts and automobility are predicated as that of a growth paradigm and accumulative economic ideologies. To change paradigms requires deep leverage points (Meadows 1999; te Brömmelstroet et al. 2020), or the ability to understand and utilize the enactment of multiple realities. Thinking in one paradigm results in inflexible systems. Accepting paradigms and thereby realities as multiples and critically and strategically choosing between different lenses are prerequisite for transcending them.

Degrowth and post-growth scholarship provide responses to automobility and growth that also Peter Cox (2023a) recognizes in the title of his paper "vélomobility is to degrowth as automobility is to growth" (see also Spinney 2021). In this scholarship, systems boundaries are provided by planetary boundaries within which new, more socially and environmentally just mobility systems can be imagined (Rockström et al. 2009; Raworth 2017).

Drawing on Kate Raworth's (2017) Doughnut Economics, Dietz & O'Neill (2013) use a bike-relatable metaphor for the cause of environmental problems that they find in a growth-oriented economic paradigm:

> As the economy expands, it consumes more materials and energy, and emits more wastes. But since we live on a finite planet, this process can't go on forever. Like an inner tube inside a tire, the subsystem can only grow so large compared to the system that contains it. (Dietz & O'Neill 2013:17)

It is argued that degrowth provides a path to subsystems that stay within a safe operating space. Post-growth systems are the aim of degrowth processes (Gough 2017), for instance of a steady-state economy (cf. Daly 1991) that features a sustainable scale, fair distribution of income and wealth and efficient allocation: important for quality of life for all citizens (Dietz & O'Neill 2013). Degrowth scholars such as Giorgos Kallis (2011) maintain that it is impossible to know the postgrowth economy, but that its prerequisites can be discerned as:

> '[A]n equitable downscaling of economic throughput' or 'a socially sustainable and equitable reduction (and eventual stabilization) of society's throughput' (Kallis 2011). It implies a sustainable and incremental move towards a steady-state economy. But this will entail radical shifts in the basic institutions of society: not only less, but different. (Gough 2017:171)

I follow Kallis' pointer of the unknowable state of postgrowth that includes a purposeful contraction of economic throughput, as well as a reconsideration of institutions. As degrowth critics frequently maintain, it is not only about a purposeful shrinking economy but about reconsidering the basic notion of well-being. The aim is to increase well-being while reducing the stress on the natural life support system. Changing economies necessitates raising awareness about their flaws and suggesting different solutions, which brings the argument back to the importance of narrative approaches, or discursive representations to construct alternative future scenarios. In these future scenarios, patterns of consumption as a main drain on resources ought to be rolled back, which requires rethinking of consumption on various scales. It has on the one hand been shown that the accumulation of money and its exchange for commodities does not automatically increase happiness (e.g. Clark et al. 2008; Stevenson et al. 2008). On the other hand, is the imperative of growth, accumulation and consumption etched into the social conscience and permeates systems that it is hard to imagine alternatives to

economic and mobility systems (Cox 2023a; Popan 2019). The governance task therefore becomes to transform systems towards less consumption on different scales through practical policies (Dietz & O'Neill 2013).

Indeed, several ideas found in post-growth scholarship align with vélomobility and NRTs and might be used as "narrative seeds" to develop further indicators for evaluating systems alternatives and outline their characteristics (te Brömmelstroet et al. 2022). The ones I foreground here are: Conviviality in relation to technology, commoning practices, autonomy and care. As with the previously introduced notions of NRTs, the four themes share commonalities and are closely related. I emphasise the four characteristics because they are reoccurring themes in vélomobilities and are sensitive to the embodied aspects of practices. As Giorgos Kallis et al. remark about degrowth: "'Sharing', 'simplicity', 'conviviality', 'care' and the 'commons' are primary significations of what this society [a degrowth society] might look like" (Kallis et al. 2014:3). The themes are efficacious to outline vélomobility characteristics and apply to collective and individual levels. In this thesis I use them as synthesising themes to discuss the three papers in chapter 6 Discussion of Findings.

3.6.1   Commoning

Economic growth provides and redistributes resources within the welfare state (Gough 2017).

> Post-growth poses fundamental challenges for the pursuit of wellbeing. It requires rethinking at three levels: the redistributive 'welfare state' at the national level, the role of the core economy at the local level, and the role of the 'social commons' within the public sphere. (Gough 2017:179)

For Gough, the public sphere exists between the state and the core economy as the discursive space where individuals and groups associate to discuss matters of mutual interest and where possible, to reach a common judgement about them (Gough 2017). A self-centred behaviour, he argues, needs to be replaced with a mutual interest in managing the commons. The notion of the commons and their governance, as famously researched by Elinor Ostrom (1990) is extended to social resources, social services and activities organized through public institutions (Gough 2017).

Applying the concept of commons, their creation and governance is suggested to help reconsider both the role of the welfare state and society to integrate environmental and social concerns. It would ideally result in eco-social policies that strike a balance between changed roles of the state, a resurrected core economy, and flourishing eco-social commons (Gough 2017). Eco-social policies can also be considered as social consumption to provide a new prominence for collective goods and services. Public institutions such as community workshops, or "non-consumerist institutions" suggest a change in consumer cultures (Dietz & O'Neill 2013:101).

Building on critique of capitalist systems and techno-optimism, mobilities scholarship has been brought into conversation with justice, transitions and commoning (Nikolaeva et al. 2019; Adey et al. 2023). These authors position commoning against the dominant government logics of scarcity and austerity. The authors build on Cresswell's (2010) understanding of mobility as movement, meaning and practice. Mobility commons seek to engender communal engagements with questions concerning mobility, including, who has access to space, how space is managed, what mobility means in particular contexts, and how mobility practices might infringe on movement and meaning (Nikolaeva et al. 2019). In that 'commoning mobility' is a reflexive exercise that foremost seeks to change governance arrangements.

Nikolaeva et al. (2019) sketch out what commoning practices in relation to mobility might entail and see their approach as a range of prefigurative practices with a substantial capacity for transformational change. The authors provide examples in describing the project RingRing and transformational mobility governance in Santiago (Nikolaeva et al. 2019:354–356; Adey et al. 2023:134–140). Their research shows how common-based forms of governance challenge top-down governance and weaken power-regimes in favour of an emphasis on just mobilities (cf. Sheller 2018). What remains unclear in these theorisations is how meaning and practices play out in dominant neoliberal logics compared to the commons approach (cf. Smeds 2023). What also remains opaque is how despite reference to the importance of experiencing practices, they actually might factor into ideas of commoning.

Here I find Benedikt Schmid's notion of "being-in-common" helpful (Schmid 2019:245), where Schmid describes narratives as:

practices' relatedness through stories, imaginaries, meanings, knowledges, theories and concepts and are closely bound up with experiences that describe practices' relatedness through affects, experiencing, capacities, habits, and aesthetics. Narratives and experiences provide a perspective around (re)subjectivation, sense-making, identification and (re)adjustment beyond individual subjects. (Schmid 2019:245)

Cycling is a social practice that is nevertheless individualized through the bicycle as a dominant cycling materiality. Affect and experience are both created in interaction with, and relation to, other people and things moving in space, but also in solitary relation to the self and materiality. Such a perspective is not only important to understanding cycling, but also repair and maintenance as both collective and individualized (cf. Paper III). It brings in experiences and affect as central components to bridge between the narrative and more visceral, embodied, through which meaning can emerge. An indicator for vélomobility is therefore a capacity for commoning, that materialises in the collective and is at the same time affective and experiential. As Benedikt Schmid argues in relation to repair: "In providing a counter-experiences, repair can shift subjectivities (including capabilities) towards preservative forms of (economic) being-in-common" (Schmid 2019:246).

3.6.2 Care

To make the relation between meaning and practice performances more evident, I turn to notions of autonomy, conviviality and care as important degrowth signifiers (Kallis et al. 2014).

Feminist economics further explicate the importance of care for well-being (D'Alisa et al. 2014). Research has shown how unpaid care work is a central pillar of capitalist systems. In light of degrowth, this creates a "strong claim for socio-environmental justice, [where] degrowthers cannot ignore the feminist claim for fairer distribution of care work; the impossibility of cancelling such necessary work has to face its inextensible redistribution across gender and class." (D'Alisa et al. 2014:64). Commoning as a collective engagement and repair studies help to position affect as a link between material re-making and re-making of the self (Isenhour & Reno 2019). These practices, the authors argue, are ethical when repair and reuse are seen as part of care practices, or better, care work. A perspective relevant if we think of navigating plurality as an inherently ethical question. Like commoning

transcends individual behaviour, care in material relations as "an ethics of attending to the other who matters may extend individual's material consumption to care about finite resources and ecological concerns" (Stevenson 2014 see Isenhour & Reno 2019:3).

In a vélomobilities perspectives, notions of care have previously been invoked to discuss the challenges of gendered mobilities of care through theories of Social Practices in Toronto, Canada (Ravensberger et al. 2020). In a study of Quito, Ecuador, Gamble (2019) shows how "women continue to be constituted as caring and relationship-oriented but, importantly, these characteristics become a positive attribute of bicycling. Rather than women being problematised for their risk aversion, lack of speed and lack of assertiveness, cycling is constituted as a site of care and joy." (Bonham & Jungnickel 2022:29f).

Being able to establish caring relationships through and with cycles then raises questions of the capabilities required to perform practices of care. I introduce autonomy and conviviality as the last two vélomobility characteristics.

3.6.3   Autonomy and conviviality

Autonomy does not negate commoning practices, but reveals an essential ability to reflect on and realise the boundaries of individualised practices. Autonomy in relation to care is also a means of self-care. In feminist perspectives, practices to increase autonomy are import to break hegemonic and gendered dependencies, for example in repair relations (cf. de Chatillon 2022).

The different autonomy definitions informing degrowth scholarship provide a deeper insight into meaning characteristics of vélomobility futures. For example, freedom and ability to commonly decide on communities' futures (Castoriadis 1987 see Kallis et al. 2014), or independence from physical infrastructures and "bureaucratic institutions" (Illich 1973 see Kallis et al. 2014:8.)

Cass and Manderscheid describe independence or freedom from hegemonic mobility confines as *autonomobility* (2018; see also Cox 2022a). As Peter Cox remarks on autonomy: "[…] vélomobilities invoke plural possibilities of autonomous human-scaled mobilities grounded in self-reliance" (Cox 2023a:13). Despite a collective sense of autonomy, it can also be thought individually in terms of self-reliance. In a material dimension, autonomy might play out in what Ivan Illich famously described as "tools for conviviality" (Illich 1973). Margot Abord de Chatillon (2021, 2022) has

brought the practices of cycle-repair and maintenance into conversation with autonomy and coined the term *vélonomy* as the autonomy in material relations with cycles.

In summary, the four interrelated concepts of autonomy, conviviality, commoning and care help in synthesising the broader notions of vélomobility for this thesis. They assist in bridging the individual and collective, the narrative with the visceral and material. Vélomobility systems are thus for the following analysis of the paper findings characterised by the extent to which the relation between its components engender conviviality in material use, autonomy as freedom from system confines on an individual and collective level, commoning as the ability for collective engagement, and care as the reproduction of relations between subject and subject, subject and object, object and practice.

This chapter sought to develop a nuanced notion of cycling as it might be understood through representational practices (cf. Jensen 2011). I presented these practices as discursive, as generated through language conceived broadly as the use of text, speech or imagery, as well as embodied and experienced in the practice of cycling. These practices I related to the cycling dimensions of people/bodies, materialities *for* and *of* cycling and spaces for cycling. This, in order to bring nuance to the analysis of the paper findings in chapter 6.

4. Methodology

This chapter explains how the research in this thesis was conducted. I begin by outlining the overall qualitative research strategy in relation to the thesis and the three respective studies in chapter 4.1, followed by Materials and Methods in chapter 4.2. Thereafter, I reflect on my position in this research (chapter 4.3) and the research process (chapter 4.4).

4.1 Qualitative research strategy

Research strategies as Bryman defines them "refer to a general orientation to the conduct of social research" (Bryman 2016:695). This research is rooted in a qualitative social science tradition. The research strategy aims to account for plural cyclings and the multiple ways in which these can be constructed in different contexts. A qualitative research strategy aligns with this open-ended and exploratory ambition (Alvesson & Sköldberg 2000). Qualitative research furthermore aligns with analytical induction, constructionist ontologies and interpretivist epistemologies (Bryman 2006).

The three studies which provide the empirical basis for this thesis are oriented at a constructionist understanding of reality, while they differ slightly regarding the leaning towards constructivism. They all share interpretative epistemologies and abductive theory relation. The studies can be differentiated according to the contexts of investigation, their theoretical orientations, empirical materials and methods. Table 3 summarises the three studies' research questions, their theoretical orientation, research material, data collection methods, and their analytical approach.

Table 3. Overview Research Strategy in relation to the three studies

Paper	Research questions	Bodies of literature and conceptual orientations	Research material	Material collection	Interpretative guide
I	What object, agents and measures of change are foregrounded in transitions research on cycling?	Sustainability transitions research as a field of study and socio-material systems	Peer-reviewed academic articles	Systematised bibliographic search in research databases and reference tracing	Abductive, oriented at "what-who-approach" (Wangel 2011; Wangel et al. 2013; Wangel & Gustafsson 2011)
II	How is Uppsala municipality discursively constructing cycling and successful cycling governance? What rationalities underpin discursive constructions and technologies of government?	Foucauldian discourse, governmentality studies, rationalities, calculative practices, technologies of government	(Municipal) cycling documents, background interviews with municipal planners	Desk research and semi-structured interviews	Abductive, oriented at governmentality themes
III	How can we conceive of the repair-cycling relationship as a social practice relation? How can a practice perspective on cycling and repair in Bike Kitchens contribute to transformational urban change?	Social Practice Theory (Shove et al. 2012)	Observation, own Bike Kitchen experiences, photos, interviews	Cycle repair events, weekly Bike Kitchen operation and semi-structured interviews	Abductive, oriented at practice elements

4.2 Materials and methods

The choice of material was informed by the theoretical orientations of the three studies in combination with their respective analytical foci and governance framings (different actors and/or institutional levels). Following Creswell & Creswell (2017), the studies rely on the standard array of material for qualitative methods: documents, interviews, observations, interactions, photographs. The material was assembled from different sources and through different methods.

4.2.1 Studying texts

Bowen (2009) suggests that documents (to which I here count written materials in general) can serve as primary research material, or as auxiliary material in conjunction with other methods. The first study, a literature review, relies solely on peer-reviewed journal papers as empirical sources. The second study also relies on texts, but mainly builds on municipal planning documents, programs and reports as well as interviews with planners. Material beyond public documents, such as reports from an advocacy organisation, helped to contextualise study II further.

To meet the thesis aim, text analyses lend themselves to studying discursive representations, their constructions and effects (e.g. Bonham & Bacchi 2017; Van Der Meulen & Mukhtar-Landgren 2021; Caimotto 2020).

4.2.2 Semi-structured interviews, photos and workshop experiences

Bonham & Bacchi et al. (2017) have shown how interviews provide material conducive to studying representations, where semi-structured interviews provide a flexible means to explore representations through open-ended questions (Brinkmann & Kvale 2018; Kallio et al. 2016). A semi-structured interview approach allowed me to follow up on utterances relevant for the research purpose, while allowing the respondents to elaborate more freely than surveys or closed interview questions (ibid.). Semi-structured interviews provide empirical material through respondents' interpretations of, for instance, events or practices. Hence, they given an insight into meaning. For the thesis aim, interviews helped to nuance my understanding of representations in the context of municipal cycling planning (Paper II) and the Bike Kitchen (Paper III). In both studies, interviews were recorded with participants' consent. Where possible, the interviews were conducted in person, but had to be replaced by online video calls on five occasions. I conducted a total of 13 interviews that were conducted in English, where participants chose whether they preferred to respond in English or Swedish. Interview methods played different roles in studies II & III.

In study II, I conducted interviews to supplement the text analysis. A first interview in the scoping phase of the study helped to contextualised the document material. Three additional interviews were oriented at municipal cycling planning (planners), means of measuring cycling (operations analyst) and an advocacy perspective on cycling governance in Uppsala (advocacy representative). The interview questions aimed at providing additional infor-

mation beyond the studied documents and to triangulate the context pertaining to the project "Sweden's best cycling city" and the award "Sweden's best cycling-promoting municipality" (cf. Brinkmann & Kvale 2018).

In study III, I used interviews as *one* method to study practices. Russel Hitchings (2012) contents that interviews are a valid approach to capture practices, ideally though, methods should be multiple. In a similar vein, Vannini has argued are no particular NRT methods (Vannini 2015 see Simpson 2020:197). Yet investigations can be adjusted through research strategies (ibid.), for example, in studying embodied practices through (auto)-ethnographic methods. In study III, I tried to attune the research strategy to practices by including my own experiences in the Ultuna Bike Kitchen and through photo elucidation in interviews. Observations and interactions at the workshops provided me with contextual knowledge that aided subsequent interviews. Where possible, I brought photographs from previous repair meetings in which the interview participants partook to the interviews and used them as conversational cues for people to talk about particular situations and practice performances (Torrönen 2002).

Additionally, though not a method that I deliberately applied, my own involvement and experiences in relation to the Ultuna Bike Kitchen allowed me to observe and interact with people that performed the practices I sought to study. I did not attempt an auto-ethnographic study and consequently did not regularly document my own reflections on workshop events and inter-actions (cf. Woodward 2019). This because at the time, I did not consider my own Bike Kitchen experiences relevant material for studying social practice relations according to the study's focus. My involvement nevertheless promotes a different understanding of Bike Kitchens and repair work compared to studying practices from the outside (cf. Manolchev & Foley 2021). I have not yet attempted to untangle how and to which extend my Bike Kitchen work has affected my research, but accept my position as biased. Involvement in cycling-related activities beyond research is quite common in cycling research (cf. Cox 2023b). I will return to this later in chapter 4.3 on my research positionality. I can assume that my experience in the Bike Kitchen sensitised me to paying attention to nuances of practices, as I adjusted breaks, patched punctures and articulated their process steps numerous times. Repair experience also made me attentive to affect in relation to the joys and frustrations of cycle repair (cf. Paper III), or the

interplay between my verbal elaborations as a volunteer, demonstrating a practice, and people being engaged in a practice.

Despite different methods and materials in the three studies, they were all analysed interpretatively with help of an abductive use of theory.

4.2.3   Analytical approach

Thematic content analyses of texts underlie the three studies (Bryman 2016; Patton 2002). Interview material was therefore transcribed and subsequently coded manually either directly in a word processor (Paper III), or with help of the qualitative data analysis software NVivo12 (Paper I & II). The papers were analysed abductively with use of the conceptual notions listed in Table 3 above.

Bryman (2016:394) describes abductive reasoning as: "[a] form of reasoning with strong ties to induction that grounds social scientific accounts of social worlds in the perspectives and meanings of participants social worlds". Compared to purely inductive or grounded theory approaches, analytical abduction employs theories, heuristics or concepts and brings them in conversation with the research material. Guiding concepts are not used as immutable categories however, but as an interpretative frame of reference that still allows for new meanings to emerge (Timmermans & Tavory 2012; Halpin & Richard 2021). For example, while theories of practice guided study III, it does not stringently employ Shove et al.'s (2012) conceptualisation of practices, but combines them with other concepts to nuance the elemental understanding of practices for the Bike Kitchen context.

According to Bryman (2016), a qualitative research orientation furthermore supports constructionist ontologies and interpretivist epistemologies. The three studies align with much qualitative social science research in that they are based on constructionist (non-realist, or anti-foundationalist) ontologies, meaning that what is real (cycles, people cycling, infrastructure, etc.) exists independently of our knowledge (Marsh & Furlong 2002).

Bonham and Johnson (2012) provide an excellent introduction to ontologies by example of cycling research (see also Cox 2022). Constructionist ontologies posit that the world only exists as a result of meaning-making processes. Constructionism does not deny the existence of a material reality, what is constructed is knowledge about reality and its meanings (Patton 2002). The materials to assemble a cycle are real, as is the final thing we call

a (bi)cycle. However, the meanings of cycles, cycling, people that cycle differ between individuals and social groups and change over time; they are pluralistic and transitory. For instance, cycling can mean freedom and flexibility for some, but mobile constraints for those for whom the cycle is the only affordable mobility vehicle. Accepting this assumption allows to position cycling, as well as cyclists or cycles as multiple.

Constructionism can analytically be further separated into constructivism and social constructionism (Bonham & Johnson 2012; see also Cox 2022). Constructivism posits the active engagement of individuals to construct meanings of the world. Research in a constructivist ontology has an interest in "how individuals relate their own experiences to the socially produced understandings of such experiences […]" (Bonham and Johnson 2016:8).

In contrast, social constructionism sees meaning-making not as an individual's process, but as a collective process. In this ontology, meanings are socially produced and not pre-existing as in a constructivist ontology. Peter Cox (2022:18) notes this when writing: "Constructionist approaches require unpacking the categories of objects and activities under examination, not assuming there are pre-existing, uncontested shared understandings of cycling practices and persons (Cox 2019)." While the three studies in this dissertation are oriented at constructionist ontologies, the overall project of this thesis — as outlined in the theory chapter — is oriented at a performative ontology (Bacchi & Goodwin 2016), in which the ontological and epistemic are blurred (Pellizzoni 2016):

> Basic tenets [of performative ontologies] are the blurring of the epistemic and the ontological, of cognition and reality; the importance of technoscience advancements, as challenging both traditional realist and constructionist accounts; and the close connection of ontology and politics, the 'real' and the 'political' being deemed to be directly implicated in one another. (Pellizzoni 2016:13)

In adopting this position, the three papers as epistemic constructions become equally performed and the focus on multiple meanings in relation to cycling shifts towards plural cycling realities. Following the theme of fractal reality constructions through methods outlined above, also the materials foreground certain cycling aspects, while pushing others into the background (cf. Law 2004). Performative ontologies allow me to treat the three papers as empirical material that purport different cycling representations. Paper I presumes

the generative character of research in departing from researchers as shaping cycling realities (e.g. Ryghaug et al. 2023; van der Meulen et al. 2023). Paper II employs a Foucauldian governmentality perspective, positing that government practices, discursive constructions, have real effects on cycling (cf. Law 2004). Paper III has an even stronger process- and relational orientation, where a changing (social) world is constructed as changing practices and their relations.

4.3   Research Positionality

Reflexivity is a process of introspection to explore values, attitudes and thought processes. It is also about (changing) my position in my research and how I situate myself and my research in society (cf. Alvesson & Skölberg 2000).

As many researchers that have engaged with the subject of cycling, I am biased towards cycling and cycles (cf. Cox 2023b). I could write much about my history with the practices and technologies, but consider it sufficient for the purpose of this thesis to acknowledge my partiality. At the sliding scale of activist-cum-researcher, my position necessarily fluctuates from attempts to maintain a critical distance (Paper I & II) to overt and active involvement (Paper III). While a vélomobilities orientation presumes a normative orientation, in this thesis (and because it is concerned with representations), I try to tread lightly and be aware of how I represent. I believe this is mostly reflected in how I try *not* to engage in criticism of motoring practices and the car. Cycling is entangled with motoring, where especially automobility renders cycling the other (Cox 2022; Mol 1999; Jensen 2011). I side with scholars sceptical of antagonistic approaches to mobility change and advocacy that posit condemnation of the car may reproduce unhelpful binaries, makes it more difficult to explore alternatives, and is likely to perpetuate exclusion and dominance of particular modes and practices in mobility thinking (Caimotto 2020, 2022). Consequently, while critical of the *system* of automobility, I tried to detach my argumentation here from critique against automobilism and the car. Instead, I foreground vélomobility ideas with a focus on cycling that stretch constructions beyond that of a multiple satisfier (Max-Neef 1992 see Horton et al. 2016:7), or mobility fix (Spinney 2021). Hence my recent interest in the experiential dimensions of cycling and longer-standing interest in cycle repair practices.

As part of the onto-epistemological position I adopt in this thesis I also consider my role in research and the methods I employ as performative (e.g. Law 2004; Hillier 2017; cf. theory chapter 3). To articulate my positionality, I can return to John Law, who promotes an understanding of the world's out-thereness that can never be caught no matter how rigorous the methods to describe them, or how exhaustive the empirical material gathered (cf. Vannini 2015 see Simpson 2022:197 on NRT methods above). Research is therefore always fractal and incomplete, but through multiplicity, research can create realities that are more than the sum of their parts. John Law terms this onto-epistemological stance of multiplicity, messiness, infiniteness and flux in research "method assemblages"; "they detect, resonate with, and amplify particular patterns of relations in the excessive and overwhelming fluxes of the real" (Law 2004:14).

I find it important to state that the "mess in social science research" John Law (2004) describes, is not meant as an excuse that anything goes in practicing research. Instead, it raises questions on positionality in research inquiry and their political ramification. If through research methods different realities are enacted, how does one decide on which ones to enact? Annemarie Mol (1999) addresses this question as ontological politics, or the reasons to promote certain realities over others. As such thoughts introduce politics in research conduct, it opens up to work towards imaginary mobility futures. It is precisely this intersection between fractal realities of cycling and their interaction with the governance of cycling with which this thesis is concerned that also makes this understanding of method assemblages relevant for the scope of this work. My contribution is a framework attuned to identifying singularity and subjugations and outlining plurality in cycling representations. Suggesting a single version of *a* vélomobility future would go against much of the literature on which this thesis is based.

4.4 Reflections on the research process

This chapter briefly describes the changes my doctoral project underwent. This enables reflection on how the project unfolded and on my changing positionality in relation to it. The linearity of a dissertation format makes it difficult to convey the many iterations and detours doctoral projects commonly take.

As many doctoral projects, also this thesis underwent changes throughout the process. While the research strategy as outlined above remained largely consistent, the research objectives and design changed over time. Dissertations tend to involve moments of iteration (see e.g. Butler 2014; Kågström 2016). With the ebb and flow of ideas and concepts, some carried through until the end, while some got lost along the way.

The multi-facetted nature of cycling, a broad governance notion, relationality and complexity in socio-material systems carried through in the project. What got lost along the way was a solutionist attitude to fix mobility problems that was replaced by questioning the constructions and effect of representational practice in relation to cycling. The realist idea of problems to be present out there, in the real world, and solutions that can one-by-one be applied to eliminate these problems, gave way to a performed understanding of multiple realities and the non-realist understanding of governance as re-emergent and aiming at moving and multiple targets. In light of this, the research strategy is less of a strategy than a process of emergence and convergence around core ideas and concepts. The three studies mirror this development. An example is that in the conclusion to Paper I, a claim that more research on the co-benefits of cycling might be needed to broaden the ways in which cycling is represented for mobility change; a recommendation that I would probably not repeat in these terms. Similarly, I would overthink the focus on cycling and repair as *urban* practices, not to reproduce binary separations between the urban and other than urban scales and spaces. Furthermore, reflective of a changing research focus, I added to the thesis a deeper engagement with representations, everything to do with performative ontologies and NRTs. I chose them in an attempt to draw the theoretically disparate papers together. The performative notion of representation by Stuart Hall (1997) in cultural studies, prompted me to re-engage with Foucauldian policy analyses (cf. Paper II) and to touch upon NRTs and ontological politics as raising questions of how to navigate a plurality of choices. In that, this most recent dissertation phase, as for many

other doctoral students, is exciting, but raises more questions than it provides answers.

This chapter presented the overarching strategy guiding the doctoral project and the more specific research designs that changed over time. I presented the qualitative methods to gather research material and how I interpreted it. I closed the chapter with reflections on my normative position in this research and reflections on the research process.

5. Summaries of paper findings

This chapter revisits the three studies underlying this thesis as interpreted in the three papers. The following three chapter present the respective papers' main findings. Thereafter, under chapter 5.4, I relate the paper findings to the research questions in this thesis.

5.1 Paper I

Few peer reviewed urban case studies focus exclusively on cycling from a sustainability transitions perspective. From these, we subjected 25 papers to review. Our results indicate that cycling as a mode of transport and mobility is not often individually brought into conversation with transitions literature. Potential reasons might include transition study's focus on (technological) innovation and interest in systemic interactions between different modes of transport. A techno-innovation focus is further reflected in studies centring on cycling technologies, most notably cycle sharing systems and e-bikes. We observe little forward-looking engagements with cycling, but more ex-post analyses and evaluations of cycling's role in urban systems. With few exceptions, "governance" is rarely explicitly mentioned compared to "planning" its associated processes and dominant planning actors.

We found that a governance lens helped us to distinguish different cycling representations. In the studies we analysed it is for instance often unclear what is and should be governed (technology, practice, or people), by whom and how. Nevertheless, the review exemplified how transitions theories can be valuable heuristics to research cycling in its multiple dimensions either individually or in their socio-technical systemic contexts. They therefore opened up for new perspectives to understand cycling practices differently.

5.2   Paper II

Cycling levels in Uppsala city have long been around 30%. This success was recently matched with the recognition of being awarded the title of "Sweden's best cycling-promoting municipality" 2018–2021. We unpack what this means for the governance of cycling by studying the rationalities and technologies of government leading up to this achievement. We find that epistemic practices, actor relations and processes of responsibilisation provide a nuanced insight into cycling governmentality in Uppsala.

Citizen feedback, their own cycling assessments and external enumerations support Uppsala municipality's infrastructure maintenance, management, and planning. Yet, we argue that Cykelfrämjandet, Sweden's largest cycling advocacy, played a decisive role in the project that would make Uppsala "Sweden's best cycling city". Linking the project to Cykelfrämjandet's assessment of the best cycling-promoting municipality, blurred the line of what success in cycling governance means. The assessment allows for an inter-municipal comparison of resources and efforts assigned to cycling, while not allowing insights into qualitative or quantitative improvements of cycling conditions or people's satisfaction with cycling conditions. Nevertheless, the project and the award strengthened cycling's representation on the municipal planning agenda, assigned more responsibility and accountability to the municipality and showed responsiveness to citizen concerns. The paper highlights the role of calculative practices in representing cycling and constructing what successful cycling governance means.

5.3   Paper III

In this paper, we brought sociological studies of materiality and repair in conversation with practice theory to outline the conceptual relations between cycling and repair. We used empirical data from a local Bike Kitchen to exemplify how Bike Kitchens affect repair practices.

We confirmed previous research findings that Bike Kitchens provide essential material for cycle self-repair. Bike Kitchens are spaces where through social interaction repair competences develop and the meanings change through practices. We find that studying repair and maintenance as embodied practices helps to better understand the intermingling of competences, materials and meanings. We show how unpacking these three practice elements can provide a detailed account of practice dynamics. We

further find that in repair the bike represents itself as people engage with the materiality of cycling in different ways than cycling. We also draw first connections between self-repair practices and Bike Kitchens as prefiguring what qualities vélomobilities futures might exhibit.

5.4   Study relation to thesis research questions

Table 4 on the next page shows an overview of research results in relation to the dissertation's research questions.

Table 4 Overview of research results in relation to the dissertation's research questions

Thesis	Contributions of study findings to dissertation research		
Research questions	**questions Study I**	**Study II**	**Study III**
1a) How is cycling constructed as objects of governance in different contexts?	discursive representations (transitions research)	discursive representations (municipal cycling governance)	more than discursive representations (Local repair initiative)
1b) As what object of governance is cycling constructed in different contexts?	technological innovation and shared cycling practices as efficient urban modes of personal transport	'normal' cycling as already dominant urban utility mobility for the productive citizen; urban cycling conditions well established; cycling as part of sustainable transport together with walking and transit	Cycles as entities requiring care; cycling practices relate to repair through cycles as material entities; Bike Kitchens provide conceptual and physical spaces for cycling support that align with vélomobility characteristics.
2a) What are the implications (effects) of these constructions for cycling's anticipated role in mobility systems?	Independent of cycling practices, cycling in most contexts unlikely to replace motorised transport.	Cycling levels to slightly increase in urban areas, because capacity is almost reached; better integration with other sustainable transport. Potentially a pluralisation of cycling practices, bodies and technologies, though not spaces	Bike Kitchens afford a pronounced position of cycling materialities; unclear relation to cycling beyond maintenance and repair to sustain cycling practices; spaces and practices prefigure vélomobility characteristics on a small scale
2b) What are the implications (effects) of these constructions on (a) cycling's role in mobility systems and the governance of cycling?	cycling continues to be a local government issue, where physical separation of modes remains the gold standard for cycling integration; plurality of cycling practices needs to be regulated; E-biking exacerbates established governance challenges through range and speed; bike sharing providers enter the cycling governance network	Outside representations of Uppsala's cycling success is important; close alignment between municipal cycling project and advocacy's evaluation indicators; Upgrades and maintenance of existing cycling infrastructure emphasised; neoliberal cycling governmentality reflected in diffusion of responsibilities and reliance of actor network including individual citizens	Different representations engender different practices; recognising the cycle as material object for cycling governance; broader actor network and potential for local initiatives
3) What lessons can be derived for working towards vélomobilities?	Representations and thereby representational subjugations are inevitable. This recognition is important to become aware of their effects. Representational practices can be reclaimed to challenge dominant cycling conceptions and nurture representational multiplicity. The effects of such representational work can be modest, but is nevertheless important.		

6. Discussion of findings

This chapter revisits and answers the research questions to meet this thesis' overarching aim to:

- The aim of this thesis is (1) to render visible the systemic entanglements that make cycling a mobility fix, and (2) to envision mobility change inspired by vélomobility imaginaries.

The sensitising questions presented in Table 2 on page 45 are therefore applied to the findings of the three papers. Overall, there are clear differences in the versions of cycling found to be represented in the paper findings. Findings from papers I and II suggest representational reproductions of cycling as a utility mode (practice) of urban (space) transport that don't allow much inference on more than the non-disabled (bodies) bicyclist (technology). Cycling, whether today (Paper II), or in the future (Paper I) remains singular, narrow and subjugated. Responses to govern cycling based on these constructions respond to problems constructed around automotive systems to keep the urban engine running. There is little engagement with cycling's plurality and the experiences pertaining to cycling experience other than to reduce risk, increase safety, convenience, and maintain spatial orders.

Findings from study III in contrast emphasise the experiences in relation to practices around cycling's materialities, where the Bike Kitchen might be seen as cautiously prefiguring vélomobility characteristics of care and autonomy in material relations, de-commodified practices and commoning. The Bike Kitchen represents itself as a space for cycling and of cycling materialities and practices.

Analysing cycling through the concept of representation overall helped to achieve the thesis aim by giving nuance to seeing cycling from different vantage points.

While this description provided a broad-stroked overview of the results, the subsequent chapters individually respond to the research questions and refine the results arguing that, there is multiplicity in representational singularity (Law 2004).

6.1   RQ Ia: How is cycling constructed as objects of governance in different contexts?

This question about modalities or mechanisms (the *how*) of representational practices is relevant to ask, because it challenges the taken-for-grantedness of cycling and its mobility roles as self-evident. It shows the implicit workings of representations but also opens for reclaiming representational practices, and the more-than representational. The three studies in this thesis investigate cycling constructions in three different contexts: research, municipal governance and a local cycling-supporting initiative. To analyse cycling constructions, I approach them in this thesis as issues of representation. Cycling in this understanding is constructed through representational practices.

Cycling in studies I and II (research and municipal governance) is constructed through discursive forms of representation in research papers and municipal cycling documents respectively. The two papers account only indirectly for lived cycling experiences. In contrast, the Bike Kitchen researched in Paper III represents cycling mainly through the embodied dimensions of practices hinging on practice performance and materialities.

Academic research, as revealed in Paper I, includes multiple layers of representation; we interpreted the representations of cycling as constructed in research and communicated in academic papers. Cycling is constructed through research methods (cf. Law 2004), where the researcher(s), their backgrounds, research settings, funding structures, as well as the theoretical frame of sustainability transitions are entangled in constructing cycling. Cycling in Paper I is then assembled through research practices and represented in academic papers. Different onto-epistemological stances reflect in research theories and methods. Here sustainability transitions, their notions of dynamically stable systems, niches and regimes and windows of opportunity affect how cycling is conceived and conceptualised in research methods. The findings as well as the paper presume the performativity of research to affect broader social and policy versions of cycling.

In municipal documents, as revealed in Paper II, cycling is represented as constructed through practice of governance. Rationalities can here be seen as representing cycling in form of underlying assumptions about what cycling is and how it ought to be governed. Uppsala municipality, Paper II argues, constructed cycling through the interlacing technologies of governance involving calculative devices and practices, actor relations and responsibilisaiton. Calculative devices include for instance: national cycling constructions, such as Vision Zero, the action plan for the project "Sweden's best cycling city" or Cykelfrämjandet's indicator list for the assessment of "Sweden's best cycling-supporting municipality". Furthermore, Uppsala's citizens contribute to co-constructing opinion polls, satisfaction surveys and the municipal error reporting system. Cycling is in this way channelled back as a representation of cycling experiences in relation to physical infrastructure and how it affects cycling practices.

The findings of Paper III reveal how cycling is constructed in and through a local Bike Kitchen. Compared to the other two papers, cycling here does not detour through discursive representations, but is constructed through the physical and symbolic space of the do-it-together cycle repair workshop and the practices enacted as part of it. This does not mean that discursive representations don't play a role at all, but that practice relations to represent cycling play an important role. Cycling is constructed discursively through communicating it on websites, flyers, and talk about also in interactions between workshop participants.

In summary, cycling across the three papers is constructed through representations in text and practice to variegating extends, showing the diversity and genesis of representations. The *how* is also relevant in relation to RQ Ib.

6.2   RQ Ib: As what objects is cycling constructed?

The paper findings revealed a close coupling between the practices and processes of representation (see RQ Ia) and the constructions of cycling as governable objects.

The representational framework helps to nuance cycling constructions as relations between practices, people and bodies, spaces and materialities. Notions derived from non-representational theories help to sensitise the cycling dimensions further, beyond discursive representations, as grounded

in practice performances and as relational. The three papers informed the construction of the framework and not the other way around. Given the disparate foci of the three papers, not all allow for in-depth analyses of all dimensions. Applying the framework to the paper findings, asking 'what cycling is constructed as', becomes an illustration and intermediary step to interpret cycling's potential role in mobility systems (RQ III). It also points towards potential implications of governance interventions to support cycling (RQ II). Because of the blind spots in different dimensions, I will often make use of their overlap to infer what aspects of cycling might be subjugated through presences and absences of other dimensions. For example, as an effect of how cycling is constructed in Paper III compared to papers I & II a clear demarcation is the extent to which the embodied dimensions of cycling are enunciated as outlined in the previous chapter (RQ Ia). I use the difference between discursive and more-than-discursive representations to structure the following discussion.

6.2.1 More-than discursive dimensions

The clearest difference in NRT-notions among the paper findings is how they foreground positive and negative practice experience. Cycle repair as a way of performing cycling materiality becomes an experiential practice with positive connotations (Paper III).

Findings in papers I and III contrast with foregrounding negative experiences relating to risk, safety, annoyance or even hostility. We found that the municipal documents invoke versions of cycling that pertain to citizens' negative experiences of cycling through facets of risk and safety. With perceived and objective safety as a major deterrent to cycling (e.g. Winters et al. 2011; EU Commission 2023), and a strong national push for traffic safety (Trafikverket 2018; Regeringskansliet 2017), it is not surprising that notions of risk can be read as permeating Uppsala's cycling governance. As reported in the municipality's bicycle accounts, the queries of Uppsala inhabitants related dominantly to wishes for separated cycling paths, defects and road safety issues linked to the physical infrastructure, and cyclists' behaviour in traffic (e.g. Uppsala Kommun 2015). With already high cycling levels, policies, plans and projects improve cycling experiences by making in dimensions of space, infrastructure and the body (cf. Paper II). In academic studies (see Paper I) the embodied dimensions of cycling are found foremost in citizens contestations of new technologies and the practices they

enable in relation to urban space. Several studies report on backlash against bike lanes, or free-floating sharing systems as disruptive to spatial orders and the mobility status quo (Paper I).

6.2.2 Discursive dimensions

More subtly, the three papers differ in the representational dimensions their findings accentuate to construct cycling. For example, the findings from Paper III address most of the representational dimensions only indirectly. It does not concern cycling per se, but repair and maintenance practices. The findings speak less to cycling practices, but Bike Kitchens speak to the performance and experience of cycling through interventions in their materiality. They represent an additional material and symbolic space for cycling and can be considered part of diverse materialities *for* cycling. The Bike Kitchen does not directly exclude a diversity of cycling practices, people/bodies, and cycling materialities, but in the Ultuna example, it also does not directly encourage plurality. Location and opening times cater to a mostly homogenous group of university students, staff and their standard bicycles.

Papers I & II are more directly concerned with cycling practices, which facilitates the interpretation of its representational dimensions. Studying municipal cycling documents and transitions research revealed increased cycling levels as aspirational in light of its manifold benefits. That is, they overall don't suggest more than cycling as a mobility fix. The review, undertaken in Paper I identifies shared and e-cycling as novel practices and the effects of introducing technological cycling innovations as e-bikes and sharing systems. Independent of the foregrounded cycling practice and the associated cycling technologies, most reviewed studies position cycling as a solution to urban mobility problems, such as congestion, air pollution, or to meet the mobility demand of a growing urban population in times of increasing environmental pressures. Implicitly or explicitly the reviewed studies appear to position cycling against individual motorized transport as sustainable, or low-carbon transport together with walking and public transit. Despite solutionist representations, most studies see a limited potential for a substantial increase in cycling levels because of automotive domination and associated planning focus in the case cities. Overall the studies suggest contestation, struggle, subordination and eventually dominance of particular forms of mobility as inevitable. Peter Cox reflects on the discursive construction of cycling in light of motoring in 1930s Britain as "[a]t one level

[involving], a crude, imperialistic Social Darwinism […] (Cox 2022:5). A similar assessment might apply to tech-focused constructions of cycling to replace individual normalised cycling. Singularity of cycling practices appears unavoidable, even when the implicit aim is the (unlikely) transition towards cycling. In Paper II in contrast, because of a less predetermined theoretical and spatial focus, effects of othering more clearly outline cycling as what it is not represented as.

Representations of cycling practices at times contradict the study on cycling governmentalities in Uppsala municipality (Paper II). On the one hand, the municipality aspires to a higher cycling mode share in line with political ambitions on higher levels of governance. On the other hand, is cycling in the municipality positioned as an urban phenomenon therefore already abundant and cycling conditions sufficient. Cycling is not expected to diversify or grow substantially, but is instead assimilated into the larger category of sustainable transport. As Paper I found, cycling is in conflict with other mobility modes, but instead of contestation, Paper II suggests constructions of mobility modes in responsible coexistence. In both papers, cycling is a spatial concern, and spatial separation from motorized mobility the ideal scenario. The Uppsala case allows more insight into the contextual nuances that render materialities for cycling an issue for upgrade and improvement from a municipal perspective. The transition studies in Paper I investigate cycling from the outside and often reach more generic conclusions, such as a demand for more cycling infrastructure, more political engagement and a wider governance network.

In line with previous research (Bonham et al. 2015; Bonham & Bacchi 2017; Spinney 2021) the productive, rational, non-disabled, male utility cyclists is in both study findings represented by marginally mentioning other cycling people and bodies. For instance, in relation to competing cycling practices, culturally embedded individual cycling exacerbates positions of difference. Studies in low cycling contexts on the other hand describe an outright exclusion, whether deliberate or not, of certain population groups. For example, when sharing systems are used as an exercise for urban branding (Sosa López 2021 in Paper I; see also Koglin & Mukhtar-Landgren 2021; Spinney & Lin 2018), when cycling is culturally stigmatised as mobility for 'the poor', merely a recreational activity, or an exclusively male practice.

In Uppsala, where cycling is normalised, subjugations are more implicit. While recognizing a diversity of people cycling (the elderly, children and adult cycling beginners), it occurs in relation to few projects and mainly in relation to behavioural approaches. Children are a foregrounded subject category that ought to be educated and trained in schools to become independent cyclist that abide by traffic rules. In three interventions, schools and the surrounding areas are special cycling spaces of concern. It has been a municipal goal to: "[…] inventory and if possible improve the traffic environment at 40 schools (with classes up to level six[6])" (Uppsala Kommun 2019:24). To facilitate mobilities of care, schools and preschools should furthermore be helped to design pick-up and drop-off locations. As common in cycling planning (Schröter et al. 2021), the desired condition is to separate different transport modes. While measures might facilitate cycling practices for care, they don't appear to encourage autonomous and playful cycling practices.

In summary, cycling across the three papers is constructed through representations in text and practice to variegating extends, showing the diversity and genesis of representations. This 'how' is also relevant in relation to RQ Ib.

6.3   RQ II: What are the implications of these constructions on cycling's anticipated role in mobility systems?

To address RQ II, I draw on the characteristics of vélomobility. The multiplicity of cycling dimensions, openness and process-orientation (reflexivity) help to answer this question that is concerned with the extent to which cycling representations can be seen as to reproduce, or transform, mobility systems. The vélomoblity notions of conviviality, care, autonomy and commoning provide further indications for (a lack of) transformative potential. Despite differences in constructing cycling, their implications on cycling's role in mobility systems is similar among the study findings. Discussing cycling's role as purported by its representations in the three papers, I find that constructions of cycling and cycling-advancing measures fit into a growth-oriented development paradigm and contribute to reproducing systems of

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[6] Level six refers to "årskurs 6" which includes children up to age 12.

automobility instead of challenging them. As identified in previous studies (e.g. Larsen 2017b; Spinney & Lin 2018; Spinney 2018), cycling becomes a fix to urban (mobility) challenges.

Hegemonic discourses tend to assimilate radical alternatives (Laclau 2005 see Castan Broto & Westman 2022; see also van der Meulen et al. 2023; Ryghaug et al. 2023). Pellizzoni (2016) asserts that neoliberalism shows similar tendencies for assimilation. The author contends that while ontological politics are a means of problematising neoliberal governmentalities, neoliberalism functions *because* it embraces the performativity of representations (politics of ontologies). Read in this way, cycling constructions as identified in the papers appear non-transformational even when traces of vélomobility characteristics might be identified.

Through the developed notions of representation, I will show how cycling in the paper findings is represented as to keep dominant mobility understandings in place, but also, how the framework might be used to identify governance measures in which cycling is represented in line with vélomobility characteristics. The aim is to exemplify, based on the paper findings, how representations together with vélomobilities might used as a way for seeing cycling and governance interventions differently

The findings are structured according to the systems' characteristics identified for automobility (progress, innovation, path-dependence, systemic closure, and consumption) and vélomobility as first introduced in chapter 2.1.3 and synthesised here as divergence, multiplicity, reflexivity with help of theories introduced in chapter 3.5. These are supplemented by the sensetising vélomobility characteristics derived from degrowth and post-growth scholarship in chapter 3.6. These are: commoning, care, autonomy, and conviviality.

6.3.1 Progress, innovation, path-dependence, divergence and multiplicity

Notions of progress and innovation feature strongly in the transition scenarios (Paper I). This may be expected given that transitions research is grounding in (among other fields) innovation studies (Köhler et al. 2019). Plurality is stifled by a focus on progress and innovation (van der Meulen et al 2023; Mukhtar-Landgren & Paulsen 2021) that is often 'smart' or 'shared' (van Meulen et al. 2023). This focus on progress and singularity is emphasised through technology, innovation and evolutionary competition between

cycling technologies and practices. The study of Uppsala municipality shows this through a vision of modal separation for safe, seamless, comfortable/convenient and integrated urban cycling (Paper II). Even in Paper III, that is oriented at the experiences of (low-tech) material-focused practices with 'normal' cycles, they are still vulnerable to assimilation and strengthening dominant systems. The results of the three studies, though to diverging extends, reaffirm myopic constellations of cycling dimensions. The representations are in line with previously established narrow cycling constructions as a practice (e.g. Horton 2016; Spinney 2016), in conjunction with people/bodies (Aldred 2010; Aldred et al. 2016), spaces (Spinney 2021; Psarikidou 2021; Koglin 2020), infrastructure (Koglin & Rye 2014; Cox 2020), and bicycles (Cox 2019). Paper III shows furthermore that inclusion and plurality is indeed an active process that otherwise caters to a narrow range of 'standard cyclists' and might become part of hegemonic discourses and branding purposes, for instance, of a cycling-supporting university (papers II & III).

6.3.2 Systemic closure and reflexivity

Striving for progress can side-line critical reflections on the implications of justice and equity in pursuing singular mobility scenarios (van der Meulen et al. 2023). Justice and equity in this thesis are mainly addressed through ethical notions of representation, such as a plurality of voices and reflexivity. A lack of reflexivity can be assigned to findings in Paper I, for example, when sharing systems were rolled-out with insufficient attention to contextual embedding (e.g., Sharmeen et al. 2021 in Paper I). Paper I accentuates the relevance of socio-cultural sensitivity when introducing novel mobility technologies and accompanied practices. It is important to note that transitions research has responded to early criticism and pays increasing attention to issues of justice and reflexivity (Köhler et al. 2019). Although less pronounced in the case of Uppsala (Paper II) the mobility scenario for 2050 is already sketched out in the masterplan (Uppsala Kommun 2017b). With the glass ceiling for normal cycling almost reached Uppsala's cycling future appears characterised by attempts for improved intermodality with public transport. In the third study, organisation and operation hinge on one person without any formulated long-term ambition for the Bike Kitchen. While not deliberately reflexive, it allows for short term adjustments and

flexible organisation, but also vulnerability and dependence as further outlined below.

Compared to a more or less pronounced lack in reflexivity for cycling futures throughout the three papers, the influence of organised or individual agents to affect visions of cycling futures and challenge systemic closure is noteworthy. It overall emphasises the importance of thinking actor arrangements in governance more broadly and the variegated roles actor groups can play in supporting, hampering, or pluralising cycling visions. Paper I found counter conduct to challenge shared cycling or cycle lanes not only as discursive, but through embodied and performed contestation. Several studies included in the review emphasise the importance of 'users' to contextualise often context-independent sharing provisions, or to purport plural and embodied visions of what cycling could be as envisioned by individual campaigners (Sengers 2017; Tuama 2015). There are tendencies to call for a broader inclusion of diverse actor groups to guide individual local projects, or to shape urban mobility futures as a whole (e.g. de Boer & Caprotti 2017). In the Paper II findings, public consultation played a strong role of the course of the investigated project to make shortcomings in cycling governance knowable and devise governance goals. Paper II furthermore shows the role of advocacies for agenda-setting in Uppsala, but also shows the pervasiveness of neoliberal governmentalities.

6.3.3   Dependence, autonomy & conviviality

The cycling constructions purported in papers I & II suggest dependence from new cycling technology, companies (Paper I) and the incumbent traffic regime that shapes discursive cycling construction (papers I & II; cf. Emanuel 2012). Instead of more conviviality, e-bikes and sharing systems hamper the potential for self-repair by adding an extra layer of technology (e-bikes), while outsourcing repair and maintenance altogether becomes part of most bike sharing business models.

Discursive dominance creates dependencies on incumbent actors to fix mobility, where cycling's futures are overcast by automobility as a frame of reference. This is exemplified through the (self)disciplinary measures found in Paper II and outlined above for example in relation to children's cycling mobilities in Uppsala. Responsibility and autonomy come close, yet I distinguish here between autonomy and responsibilisation. Autonomy in mobility is the freedom from hegemonic system constraints (Cass & Manderscheid

2018; see also Cox 2022); the capacity for options to fulfil mobility needs. In contrast, responsibility invokes obligations to perform in certain ways. Calls for 'mutual consideration and respect' in traffic conduct (cf. Paper II) blurs the line between autonomy and responsibilisation. They invoke the responsibility of caring for others, which might explain why behavioural measures have become popular under neoliberal governmentalities as a mode of steering at a distance (Doughty & Murray 2016).

A few positive examples of collective and individual autonomy shine through in papers I & II. For example, where the municipality constructed cycle service stations, public bicycle pumps and a washing station in Uppsala to enable care for cycles. Or where peer-to-peer sharing of bicycles is presented as a business model for cycles, or social entrepreneurial sharing provisions (e.g., van Waes et al. 2018; Sunio et al. 2020; e.g. Sharmeen et al. 2021). The Bike Kitchen might foreground autonomy in material relations the most in that it enables care for cycles. Yet, also the Bike Kitchen does not operate completely autonomously, but depends on locales and resources.

6.3.4 Consumption, reproduction and care

The surge for more cycling is to keep a growing (urban) population as mobile as possible. The implication of this part of normalised utility cycling, with a focus on the productive citizen, manifests current understandings and patters of mobility that are strongly coupled to consumption (Spinney 2021, Cox 2022). In the study findings, these, once more, become visible through the absences of everything that is not 'normal' bicycling. For example, findings in Paper I suggests a potentially emphasised potion of sharing systems in urban mobility systems. Cycling under these scenarios becomes a service to be purchased and repair and maintenance part of the service package. This stands in contrast the findings in Paper III, where repair is a reproductive practice.

In an interview excerpt conducted as part of study III, a participant describes hands-on repair work to balance out the mental work in their regular job that can be seen as reproductive: "One thing is that I feel like I'm doing so much with, with my mind in my work, so one part is just to do something more practically and with my body" (#8). The same person reported that this practical work relates to becoming "more comfortable with own skills" (#8). The paper findings show how Bike Kitchen work can be about reproductive activities in a personal, social and material context. The

notion of caring practices is furthermore found in Paper II, where cycling children to school becomes part of parents' caring activities that the municipality caters for. The care for other road users in Paper II invokes responsibility and consideration for traffic participants to care for each other.

6.4 RQ III: Based on RQs I & II , what lessons can be derived for working towards vélomobility futures?

I can make no claim for generalisation from three rather heterogeneous cycling studies. These are therefore suggestive, rather than conclusive lessons informed by the paper findings and the literature on which this thesis builds.

The representational dimensions I introduced are just that: representations. They offer a different way of looking at, and thinking about, cycling in its complexity and the ways in which (more-than) representational practices can work to foreground some cycling dimensions, while backgrounding others.

There are several examples of projects and policy interventions that prefigure vélomobility-compatible characteristics. Yet, contestability, reflexivity and openness of systems limit the potential for accelerated and deep reaching transformations. Where automobility is a system of self-perpetuation, vélomobility is process-oriented and deliberately open in outlining characteristics, not a singular version of what a vélomobility version might look like. Beyond that, and as argued throughout the thesis, replacing automobility systems without changing the underlying growth paradigms might increase cycling levels, but is unlikely to transform mobility systems. Returning to the importance of narrative approaches for systemic mobility change and the imperative of changing meanings surrounding mobility, some necessary requirements might be outlined based on this thesis.

First, representation is immanent in any attempt for governance (Rose 2016). The thesis sought to show how representations matter and that they have performative effects. Accepting that representations are pervasive and have effects is a necessary precondition to mobility change; to question the hegemony of certain constructions and to develop alternatives (Ryghaug et al. 2023). A performative ontology is argued to be emancipatory in that it recognises that all representations can have effects (cf. Pellizzoni 2016). The three papers have shown that cycling governance is not only what spatial and transport planners enact. A range of actors can play divagating roles in governance processes and in doing so enact particular versions of cycling. While dominant representations appear stable, they are in constant flux. Looking at cycling as the relation between different representational dimensions, different contexts and different arrangements can reproduce established or generate new versions of cycling. Awareness of agency does not necessitate responsibility, but can be used in turn to invoke responsibility

in government. This is shown by examples of claiming cycling spaces, rejecting sharing systems (Paper I), shaping governance indicators and reporting dissatisfaction (Paper II), or that under the right circumstances, individual's ideas can propagate alternative representations (Paper III; Sengers 2017 see Paper I). Recognising that governance relations can be more than established regimes and that different visions of cycling futures are essential to challenge dominant cycling representations are therefore an important prerequisite for working towards vélomobility futures.

Positioning representations as performative in this thesis foregrounds the effects of also narrative approaches. I developed the framework as a tool to recast cycling constructions differently and analyse how different actors in different contexts employ representational practices to obdurate adverse systems' characteristics. It made me aware of how in a multitude of contexts, different actors in academia, municipal planning and local initiatives, affect cycling governance through representations of cycling and the problems constructed alongside it. This is, alternative discourses can and need to be developed and strengthened in different contexts to challenge dominant ones.

Second, Recognising, recovering, developing and perpetuating notions, or characteristics of alternative cycling imaginaries are a second point of importance. I outlined these as desirable systems' characteristics that can be found in past and present practices (cf. Shove 2012). I've shown that even in representations propagating mobility status quos, they may offer insights, for instance, into the importance of new systemic approaches to understand cycling through transitions lenses (Paper I), of attuning cycling-supporting interventions, including new cycling technologies and services to local contexts, and how 'users' play divagating roles as governance actors (papers I & II, cf. Sharmeen et al. 2021). Bringing diversity of different cycling arrangements to the fore is also a way of opening up for a plurality of mobility visions. Here, the discussion revolved around cycling, but considering the requirement for plural mobility imaginaries, other practices, such as walking and public transit, but also motoring practices, ought to be part of a similar pluralisation and become integrated into Anthropocene mobility imaginaries.

Third and last, despite the importance of discursive representations, I tried to stress the point that the embodied, performed and experienced dimensions of practices are crucial for changing meaning in relation to practices. It is a conundrum that in order to change meaning through practices, they need to

be performed. It has previously been argued that accounting more for the embodied and sensory experiences of cycling in planning should receive more attention (Spinney 2021). Ironically, safety is a central concept and point of concern in cycling governance that currently comes closest to incorporating lived cycling experiences (e.g. van der Meulen 2023). But as touched upon in relation to Paper II, seasonal cycling might be considered a pluralisation of cycling affording different experiences. Paper III shows how repair and maintenance of cycles involve affect and that more-than representational dimensions are crucial for meaning-making and shaping in relation to other practices, such as cycling. Like the Bike Kitchen example supports cycling indirectly through material care, thinking the relations of cycling to other practices might engender previously unthought, or marginalised perspectives on governance interventions (Mock 2022; Kent 2022; Cass & Faulconbridge 2016).

This chapter has revisited the research questions and answered them by applying a framework developed around representation of cycling to the three papers in this thesis.

6.5   Concluding remarks

This chapter concludes the thesis. Following a short synopsis of the papers' contributions in relation to this cover letter, I provide a more elaborate summary to detail the theoretical contribution I consider this thesis to make as well as, though to a lesser extent, the empirical contribution. I end with reflecting on some caveats of the thesis that also point towards further research.

Throughout this thesis, I've sought to substantiate the claim that representations as meaning producing cycling, matter for cycling governance (Aim I), with the overarching ambition of outlining how different representations are unintentionally employed and might be used purposefully to reconsider cycling (Aim II). I've started to outline the interactions between governance, and different 'channels' of representations outlining *how* some dominant representations facilitate certain 'cyclings', while subjugating others (papers I & II) and with *what* implications on cycling (Paper II).

Mental representations — the way we think about cycling as relations between mental concepts and images — make cycling meaningful. This with inevitable effects on how we codify and represent cycling beyond language, but also through cycling practices, people cycling, cycles and spaces. I

employed this conceptual breakdown to capture cycling's complexity through the relations these 'dimensions' can form. In the counterflow of representations, such an understanding of cycling through representations might be used analytically in two ways: first, to question the representations underlying governance efforts and second, to interpret the leverage points of governance interventions; do they leverage at practices, people, cycles and/or cycling spaces? I then showed how cycling's relations might be applied to guide cycling-focused interventions as an alternative means for governing cycling (Paper III).

Departing from the practice relations between cycling, repair and maintenance, I explored how a Bike Kitchen might dominantly represent cycling's material dimension and invoke different meanings of cycling (Paper III). At this point, it is important to remind of the open-endedness of governance efforts, particularly when seen from a systems perspective and the underlying ambition of fundamentally changing urban systems of mobility and transport. Governance in this understanding is not a linear process but bound to iterations and recalibrations of aims and means (Hillier 2007). The perspective on cycling developed here assisted me as a tool to explore representational complexity and recognise that the governance-representation nexus offers various entry points to think differently about cycling and its governance.

6.5.1 Contribution

Though empirically grounded through the three papers, I consider the contributions made throughout this thesis mainly theoretical, as I bring different research strands together in a novel arrangement.

I opened with the problem of cycling's implementation gap, which in turn brought me to deeper problematizations; the reciprocity between mobility, automobility and pervasive paradigms of growth (Spinney 2021; Manderscheid & Cass 2023; Cox 2023a). The thesis turned into an exploration of this relationship, specifically how cycling is constructed to respond to different problematizations, to fix mobility or transform mobility meanings.

I've brought mobilities studies and critical mobilities scholarship together with vélomobilities research to signal their shared concern with mapping out and potentially changing, social understandings of mobilities. Based on this literature, I argued that to change mobilities, the way mobilities are

conceived of and their meanings, ought to change. A change of meaning through narrative approaches has received increasing attention in these regards (Ryghaug et al. 2023; te Brömmelstroet et al. 2022) and this is also where I position this thesis. I've recast narratives and discourses as matters of representation and explored in different contexts (research municipal cycling governance and local cycle repair initiative) the implications of these constructions on how cycling is conceived of by different groups of actors in different mobility scenarios. I've brought together notions of Foucault-inspired policy analysis (e.g. Bacchi & Goodwin 2016), Science and Technology-affiliated scholarship (e.g. Law 2004; Mol 1999) under a performative positioning of ontology. The critique of representationalism as dominated by an interest in texts and visual renderings to convey meaning has then allowed me to hone in on the more-than-representational notions of cycling as entangled in practice arrangements. Turning to NRTs I've included practices as performed, material, embodied, affective, visceral and relational. I've thereby aligned NRTs with a flat ontology that in turn, I've suggested, syncs with scholarship interested in the construction and effects of representations. This then allowed me to close the circle to vélomobilities and particularly recent suggestions on what characteristics vélomobility systems ought to exhibit to challenge the hegemony of systemic automobility and move beyond mobility fixes (Spinney 2022, Cox 2022). I've synthesized plurality, contestability, inclusivity, openness, and reflexivity as rough guidelines for such systems conceptualizations. To sensitize these characteristics further, I've returned to critical mobilities scholarship (e.g. Abey et al 2023; Nikolaeva et al. 2019) and took further inspiration from degrowth and post-growth scholarship (e.g. Gough 2017; Kallis et al. 2014). In doing so, I've suggested conviviality, commoning, care and autonomy as intersecting synthesizers that might provide new perspectives on mobility while tending to the critique of growth and accumulation.

Combined with established ways of conceptualizing cycling as an intermingling of practice, people/bodies, materialities and space (cf. e.g. Cox 2019; Cresswell 2010), I've devised a framework to analyse cycling practice and governance approaches to advance cycling. Applying the framework to the three papers in this thesis, I've sought to show how cycling is constructed in different governance contexts, broadly conceived, and with what implications on transforming, or 'fixing' mobility.

The three papers then provide the empirical contributions this thesis makes in light of mobility transformations and cycling research. Study I confirms previously established positions about an ecomodern, technology-optimistic orientation in transport research (Ryghaug et al. 2023) and research founding (van der Meulen et al. 2023). I've shown how in transitions research, cycling can become the 'other' to ecomodern and technology-centred ideas of mobility futures. But also, that the blanket critique towards transitions studies as regards a claimed insensitivity to power, inequality, inequity and justice, has been addressed, or is at least a less critical issue in the selection of papers underlying study I. Several paper contributions in the review have shown how transition lenses might be applied to render cycling and entangled mobility issues visible in alternative ways, represent cycling in its multiplicity and be attuned to highlight subjugations. In study I this probably became clearest concerning wider inclusion of people and spaces.

Study II confirms how government practices implicitly representing cycling as safety concern that is a matter of responsibilisation. It adds weight to the argument that inter city competitions and branding are important (Spinney 2021) and that in a context like Uppsala, the normalisation of cycling can be represented as extraordinary. Paper II furthermore explicates the workings of neoliberal governmentalities on cycling in Swedish contexts. It shows the crucial role of a wide and diversified actor network to represent problems around cycling. It emphasises the crucial position of cycling advocacies in Sweden to govern cycling (Balkmar 2020). The study furthermore emphasises citizens' roles in shaping and problematising planning, management and maintenance priorities for cycling through their everyday mobility experiences.

Paper III explores the potential of a Bike Kitchen to change meaning through the interlinking of practices and materialities relating to cycling. It shows the importance of sociality and affects in initiating and sustaining practices of cycle repair and maintenance. It also shows that habitualising practices and changing meaning are difficult to achieve through one-off engagements, but require active nurturing. The study furthermore hints at the pervasion of neoliberal governmentalities to potentially assimilate also degrowth-oriented initiatives. Paper III hints at the difficulty of protecting practices aligning with degrowth ideas from responsibilisition (Schoppek 2020) but also that degrowth initiatives are not automatically just (Bauhardt 2014).

Jointly, the three papers sketched out some of the issues inherent in dominant cycling representations as reflections of attempts for fixing mobility through cycling, but also how by unpacking representational practices and their effects, lessons for alternatives might be uncovered.

6.5.2   Final reflections and future research

This chapter concludes this thesis with an inconclusive list of issues and possible research trajectories I encountered while writing this thesis.

In an attempt to keep this thesis brief, the connections and synergies between different theories and concepts as well as previous empirical findings are often only broached, but deserve further articulation and elaboration. These related to the use of reflexivity, multiplicity, what I termed 'vélomobility characteristics', issues of power and justice, and notions of NRTs vis-à-vis discourse.

The framework as developed here lacks sensitivity to operationalise reflexivity, multiplicity and the characteristics of commoning, care, autonomy and conviviality. It would benefit from more clarity on the levels of practices and systems these concepts speak to. While I tried to make clear throughout the argumentation that reflexivity refers to mobility systems' properties to identify emergent issues and respond accordingly, this might have been made clearer. Multiplicity refers to both the multiplicity of possible practices and, as a result, visions for plural systems. Relatedly, previous studies have employed selected degrowth markers, with fewer studies offering a more comprehensive framework (Cattaneo et al. 2022; Vetter 2018). Mobility-sharing schemes appear promising but warrant caution under considerations of justice and equity. Location and pricing are only two potentially excluding parameters. Sharing schemes also raise the here untapped issues of representation when cycling in sharing companies' databases becomes a commodity and cycling virtual mobility where representations are opaque to bike share users (e.g. Spinney 2021; Lin & Spinney 2021).

I could only touch upon the value of non-representational theories to analyse practices. The broad literature base on practice materiality, affect, experience, embodiment and emergence deserves further attention. Despite a proliferation of cycling research and broader representations of Social Science and Humanities perspectives, or non-realist cycling research more

broadly, there remains further potential for NRTs to contribute to policy, planning and governance with a stronger emphasis on experiences.

Issues of justice and power, while central to representations, have only been mentioned in passing in this thesis. How alternative cycling representations can begin to challenge dominant ones warrants further investigation. Based on previous research I could identify policy, planning and academia as influential arenas perpetuating forms of cycling representations (Jensen et al. 2017; Tschoerner-Budde 2020), and could confirm some of these tenets through papers I & II. This then stands in contrast to the local experimentation side of the Bike Kitchen. I advocate plurality and reflexivity and through ontologically grounding my approach in performative ontologies, where the efficacy of such arrangements to challenge dominant discourses is another open question that goes beyond the scope of this thesis. Transitions frameworks and urban studies on experimentation, might provide insights on how to 'grow' local initiatives out of their niche status (see also te Brömmelstroet et al. 2022). But the question arises if growth of grass-roots initiatives is actually a desirable condition under de- and post-growth scenarios or if polycentric networks of small, localized, initiatives might respond more adequately to local needs in certain contexts (Krähmer 2022; Mocca 2020). At this point, I want to insert a small side note that resonates with the Bike Kitchen paper and the issue of scaling degrowth through policy (cf. Persson 2022).

On the 21st of November 2023, the European Parliament adopted a proposal to support "more sustainable consumption, by making it easier to repair defective goods, reducing waste and […] the repair sector." (European Parliament 2023). The decision is carried by a majority of 77% of EU citizens who would rather repair than purchase new products (European Commission 2014). It entails improved after-market services, such as extended warranties, information on "local repair providers (including repair cafés)", availability of spare parts and DIY repair information (European Parliament 2023). The council is to start talks with the parliament in December 2023 and the implementation on national levels will show the efficacy of the "right to repair" in member states in the coming years. Nevertheless, in my opinion, the motion sends a hopeful message against mass consumption, planned obsolescence and the ensuing waste generation of irreparable products. It also seeks to "empower consumers for the green transition" (European

Parliament 2023). I see a couple of potential implications for small-scale do-it-together initiatives, such as Bike Kitchens.

First, it is a signal to the public that easier repair is needed as well as desired. Second, the motion might strengthen the position of non-commercial repair initiatives alongside commercial and aftermarket repair. Third, it might increase the visibility and potential of such initiatives for citizens as a viable alternative to commercial repair or product replacement. Fourth, it thereby might reduce barriers for people to re-engage with everyday materialities, such as cycles. The bike kitchen study has pointed towards the ephemeral and affective dimensions of cycle repair. Granting DIT-repair a stronger legal standing might contribute to changing meanings entangled with cycles, as well as repair and maintenance services.

As part of a lack of mobility imagination, non-standard cycling practices, as a combination of different cycling dimensions, warrant further research attention. For instance, regarding people and bodies, research with children on their (autonomous) mobility practices might illuminate the emergence of different meanings of cycling and problematise current affordances for children's cycling in planning and policy (e.g. Silonsaari et al. 2023). Apart from slow and social cycling mobilities (Popan 2019; te Brömmelstroet et al. 2017), recent research has also begun to engage with alternative, economically 'unproductive' cycling practices, such as non-commercial co-mobility services for people challenged to perform 'normal' cycling on their own to experience cycling mobility and take part in public social life. In a similar vein might research with and for people with diverse disabilities engender reflections on mobility meaning. Research conducted together with different people and bodies might furthermore question the affordances of standard bicycles as *the* materiality of cycling, where people may require more than two wheels, a different centre of gravity while cycling, accommodation of multiple people, etc. These non-standard cycle designs then also problematize materialities *of* cycling and cycling spaces as cycles may be longer, wider, and heavier, with different curve radii, and deceleration properties. Issues in these realms already emerged on cargo-cycles and their special affordances regarding the width of cycling lanes, or provision of adapted parking infrastructure (Dalla Chiara et al. 2023), and might provide a starting point for further investigation.

While this thesis considers the intermingling of practices, materialities and spaces in short time windows, historic studies of cycling, or related

practices in Uppsala may investigate the ebb and flow of differently nuanced cycling practices. Previous research has shown the value of historical analyses to address potential shortcomings of NRTs. While NRTs might be attuned to the emergence of practices as they are performed, it is difficult to account for the structuring, and exclusionary effects of, for example socio-economic background, or what Emanuel (2023 after Kärrholm 2017) termed the "seriality" of mobility (cf. Emanuel 2023:710). Similarly, historic studies of mobility could account for rhythmicity in a socio-spatial and temporal context (Emanuel 2023).

Degrowth scholarship offers a growing body of research on degrowth-compatible practices. I've touched on some of this literature in Paper III about repair and the theory chapter of this thesis. These micro-practices often foreground the experiential aspects of practices, which might be brought into conversation under the theme of practice connections and meaning (Mock 2023). It is nevertheless important to bridge from individuals' practices to policies and eventual societal change. More studies at the planning-degrowth intersection might be beneficial in these regards (Lehtinen 2018; Wächter 2013; Xue 2022).

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Popular science summary

Cycling is a healthy, inexpensive and virtually emission-free means of moving around. Numerous countries share ambitions to encourage people to cycle more and use particularly the car less. Especially in light of the climate crisis, cycling is often thought of as a vital part of mobility transformations. It means a complete restructuring of the way we think about the role of mobility in society and consequently move around its modes of transport and generally the interplay between social and material elements (regulations, rules, institutions infrastructures, etc.).

Everyone probably knows of some cities considered "bicycle friendly", but in many local contexts cycling only plays a marginal role, if any at all. To encourage more people to cycle more and more often, it is established in research and practice that cycling infrastructure, such as bike paths, is important for people to feel safe while cycling. Cycling ought to be supported and normalised while motorized traffic discouraged and reduced. But the claimed ambitions to support cycling don't seem to match cycling's benefits, let alone the call for mobility transformations.

This thesis takes these problems as prompts and explores what lies behind these mismatches. There are many issues at play here that hamper progress in cycling's development, from a lack of political support, over low planning ambitions, to individual attitudes towards cycling with variations in different contexts. Yet, what lies behind these issues is a narrow conception of what mobilities are and what they are supposed to be for, including cycling. The way we think, talk, write about, enact and experience cycling — the way it is represented — has implications for how local government, researchers, and every one of us relates to cycling. It thereby also affects the ways cycling is, or could be supported. This thesis therefore explores how cycling is represented and how and why representations matter. It seeks to contribute

to a better understanding of cycling's implementation gap and to think of new ways for governing cycling in light of mobility transformations. The argumentation here departs from an understanding that this requires more diverse representations.

Building on the concept of representation, this thesis presents a notion of cycling as an interplay between cycling practices, people and bodies cycling, spaces for cycling, its infrastructures and cycles themselves. This nuanced notion of cycling is used to explore how different versions of cycling are brought into existence in three different contexts as combinations of the different cycling dimensions. The contexts reflect different governance levels and actor groups affecting cycling in different ways. Each is explored in a research paper that together forms the backbone of this compilation thesis.

First, scrutinising representations of cycling in research, I argue that the field of sustainability transitions studies does not assign an important role to cycling for transformations. It has so far largely explored techno-optimistic innovations of cycling while side-lining the diversity of 'traditional' everyday cycling. The roles different actors outside established governance regimes can and could play in strengthening cycling's positions as an urban mode of mobility and transport and work towards transforming mobility systems offer a promising starting point but are not very well established in this research branch. Second, in Uppsala, where cycling holds a strong position, the thesis shows how despite cycling's normalisation, municipal documents reproduce a narrow version of urban utility cycling. While the municipality sees itself responsible for managing and maintaining cycling infrastructure, Uppsala's citizens are responsible for taking care of each other as considerate traffic participants. Uppsala, compared to the research context, exemplifies a case where governance is enacted in a wider actor-network, where citizens and advocacy organisations are important for shaping measures to support cycling. It also shows why it is important to be considered a bicycle-friendly city. The third paper concerns a free cycle repair workshop at SLU's campus. I initiated this so-called 'Bike Kitchen' and investigated how cycling might be supported through a local bicycle repair initiative. I contend that the Bike Kitchen add a flexible means of governing cycling's quality and safety by engendering assisted cycle self-repair. This is with implication for how cycling in conjunction with repair is represented as a sustainable, sufficient mobility mode and the bicycle as an entity of care.

All three cases show the inevitability of representations. Dominant cycling representations as in the first two cases operate in the shadow of automobility as the standard ways of seeing cycling as a fix for urban problems caused by automobility, but not automobility alone. In these scenarios, cycling might replace the car for many trips, but this is not enough for fundamental transformations. They reproduce versions of cycling linked to paradigms of growth, where more is better, and the bike a vehicle to sustain continued green urban development. The pursuit of such ambitions, as purported by de-growth and post-growth literature, does not align with fundamental transformations that respect Earth's planetary boundaries for life support. The third case is then an exploration of alternative practices to represent cycling in light of degrowth characteristics.

None of the examples provides a blueprint for cycling's potential role in mobility transformations, but all provide valuable lessons. To overcome the implementation gap, or fundamentally change mobility systems, a plurality of cycling representations is important. This means developing representations that broaden ideas of cycling beyond that of only an urban mode of transport for the middle-aged, male, white, non-disabled, standard bicyclists. It includes representations of cycling as combinations of different cycling practices, people and bodies, spaces and materialities.

Populärvetenskaplig sammanfattning

Cykling är ett hälsosamt, billigt och i princip ett utsläppsfritt transportsätt. Många länder har gemensamma ambitioner att uppmuntra människor till att cykla mer som ett miljövänligare alternativ till att åka bil, särskilt i ljuset av klimatkrisen betraktas cykling ofta som en viktig del av mobilitetsomvandlingen. Detta innebär en fullständig omstrukturering av vårt sätt att se på rörlighetens roll i samhället och följaktligen för hur vi rör oss och för transportsätt i allmänhet och därmed samspelet mellan sociala och materiella faktorer (förordningar, regler, institutioner, infrastrukturer osv.)

De flesta känner nog till ett par städer som anses vara "cykelvänliga", men i många lokala sammanhang spelar cykling bara en marginell roll, om ens någon. För att få fler att cykla oftare är det etablerat inom forskningen och praktiken att cykelinfrastruktur, till exempel cykelvägar, är viktiga för att människor ska känna sig trygga när de cyklar. Cykling bör stödjas och normaliseras medan motoriserad trafik bör motverkas och minskas. Men de påstådda ambitionerna att stödja cykling verkar inte stämma överens med cyklingens fördelar, för att inte tala om uppmaningen till mobilitetsomvandlingar.

Denna avhandling tar dessa problem som en uppmaning och utforskar vad som ligger bakom dessa missmatchningar. Uppenbarligen finns det en problematik här vilken hämmar utvecklingen av cykling som transportsätt, från brister på politiskt stöd, över låga planeringsambitioner, till individers attityder till cykling med variationer i olika sammanhang och kontexter. Men det som ligger bakom denna problematik är en snäv uppfattning om vad mobilitet är och vad mobilitet ska vara till för, inklusive cykling. Hur vi tänker, pratar, skriver om, manifesterar och upplever cykling – hur det representeras – har konsekvenser för hur kommuner, forskare och för hur var och en av oss förhåller oss till cykling. Det påverkar därmed också vad cykling

är och hur cykling skulle kunna befrämjas. Denna avhandling undersöker därför hur cykling representeras samt hur och varför olika representationer av cykling spelar roll. Syftet är att bidra till en bättre förståelse av cyklingens implementering och att belysa nya sätt att tillämpa cykelimplementering i ljuset av mobilitetsförändringar. Argumentationen här utgår från en förståelse för att detta kräver mer diversifierade representationer av cykling.

Med utgångspunkt i konceptet representation presenterar denna avhandling en föreställning om cykling som ett samspel mellan cykelpraktiker, människor och kroppar som cyklar, platser för cykling, dess infrastrukturer samt cykeln i sig självt. Denna mer nyanserade syn på cykling används för att utforska hur olika uttryckssätt av cykling uppstår i tre olika kontexter, som kombinationer av olika cykelföreställningar. Kontexterna speglar olika förvaltningsnivåer och aktörsgrupper som påverkar cykling på olika sätt. Var och en av kontexterna utforskas i separata forskningsartiklar som tillsammans utgör ryggraden i denna sammanläggningsavhandling.

För det första, genom att granska representationer av cykling inom forskningen, argumenterar jag för att tidigare studier av hållbarhets-övergångar inte ger cykling en tillräckligt viktig roll i omvandlingen. Den tidigare forskningen har hittills till stor del utforskat teknikoptimistiska innovationer inom cykling, samtidigt som den har åsidosatt mångfalden av "traditionell" vardagscykling. De roller som olika aktörer utanför etablerade styrregimer kan och skulle kunna spela för att stärka cyklingens position som ett urbant transportsätt, och arbetet för att omvandla mobilitetssystem erbjuder en lovande utgångspunkt men hittills inte särskilt väletablerad inom denna forskningsgren. För det andra, i Uppsala, där cykling som transportsätt har en stark ställning, visar avhandlingen hur kommunala dokument trots en normalisering av cykling alltjämt reproducerar en smal version av urban nyttocykling. Medan kommunen ser sig själv som ansvarig för förvaltandet och underhållandet av cykelinfrastrukturen, har medborgarna i Uppsala ett ansvar att agera som hänsynsfulla trafikanter. Uppsala, jämfört med forskningskontexten, exemplifierar ett fall där styrningen av cyklingen sker i ett bredare aktörsnätverk, där medborgare och intresseorganisationer är viktiga aktörer i utformandet av åtgärder och stödjandet av cykling. Det påvisar också varför det är viktigt att betraktas som en cykelvänlig stad. Den tredje artikeln handlar om en gratis cykelreparationsverkstad på SLU:s campus. Jag initierade ett så kallat "Bike Kitchen" genom vilket jag undersökte hur cykling skulle kunna stödjas genom lokala cykel-reparationsinitiativ. Jag har

slagit fast att ett "Bike Kitchen" tillför ett flexibelt sätt att styra cyklingens kvalitet och säkerhet genom skapandet av en assisterad självreparationsservice för cykel. Detta med implikationer för hur cykling i samband med reparation representeras som ett hållbart och lämpligt mobilitetssätt och cykeln som en vårdenhet.

Alla tre fallen visar att representationer är oundvikliga. Dominerande cykelrepresentationer som i de två första fallen verkar i skuggan av se automobilitet som standardsättet och att se cykling som en lösning på urbana problem orsakade av automobilitet, men inte enbart automobilitet. I dessa scenarier kan cykling ersätta bilen för många resor, men det räcker inte för grundläggande förändringar för hur vi ser på transport. De reproducerar endast versioner av cykling kopplade till tillväxtparadigm, där mer är bättre, och cykeln endast som ett fordon för att upprätthålla fortsatt grön stadsutveckling. Strävan efter sådana ambitioner, som tas upp i litteraturen om degrowth och post-growth, är inte i linje med grundläggande föränd-ringar som respekterar jordens planetära gränser. Det tredje fallet är en under-sökning av just alternativa praktiker för att representera cykling i ljuset av degrowth-strukturer.

Inget av exemplen ger en modell för cyklingens potentiella roll i mobilitets-omvandlingen, men alla tre fallen ger värdefulla lärdomar. För att överbrygga bristen på genomförande, eller att i grunden förändra mobilitets-systemen, är det viktigt med en mångfald av cykelrepresentationer. Detta innebär att utveckla representationer som vidgar föreställningar om cykling bortom det om enbart ett urbant transportmedel för medelålders, manliga, vita, arbetsföra, vanliga cyklister. Denna omvandling måste innehålla representationer av cykling som kombinationer av olika cykelpraktiker, människor och kroppar, rum och materialiteter.

Papers

I

REVIEW

Open Access

Representations of urban cycling in sustainability transitions research: a review

Daniel Valentini[1*] , Josefin Wangel[2] and Sara Holmgren[1]

Abstract

Background Increased cycling is generally recognized as a highly important project in decarbonizing urban transport. Despite well-researched and broadly accepted benefits of cycling, bicycle mobility plays only a marginal role in the modal share for most cities.

Purpose To make sense of this paradox, this review article investigates how cycling research engages with the governance of cycling. The review focuses on how cycling mobility is envisioned, approached and described within the change-oriented field of sustainability transitions research.

Findings Through a systematic reading of 25 peer reviewed scientific journal articles, we find that the articles mainly focus on technological objects of change (e-bikes and bikesharing systems); incumbent actors; and established planning and policy measures applied to new contexts. Most studies are evaluative, lacking the forward-looking and change oriented ambition transitions research set out to address. To contribute to increased cycling mobility in urban contexts, we conclude that future cycling research might benefit from adopting more diverse and clear notions of governance objects, actors and measures.

Keywords Urban cycling, Cycling practices, Cycling technologies, Sustainability transitions, Transport governance

1 Introduction

Increased cycling is generally recognized as an important project for decarbonizing urban transport and personal mobility [23]. Despite the benefits of cycling being well-researched and broadly accepted, bicycle mobility plays only a marginal role in the modal share for most countries [10, 41, 42]. The reasons for this discrepancy are multifarious and context dependent [14]. However, we suggest that a potential part of the answer to this paradox lies in how cycling is represented as an object of governance, and the way changes in cycling are envisioned, approached and described in research.

In this article, we review cycling research approached through lenses of sustainability transitions research, a field of study that in recent years has received increasing attention due to its orientation towards understanding and guiding fundamental change processes, including within transport and mobility [38].

Transitions and transformation are two terms often used interchangeably [34]. In this article, we acknowledge their original conceptual difference and delineate our review to transition studies. Transitions research tends to focus on societal sub-systems, suited to our investigation of urban cycling. While transformations research, typically centers on socio-ecological relations on different societal levels, cutting across different (urban) domains (ibid.). Transition studies are concerned with the modalities of change, the relation between facilitating and blocking mechanisms, essential, we claim, for investigations of cycling governance. Despite our focus on transitions, dominant transitions frameworks don't exclude transformations, but conceptualize them as one

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of several pathways in transitions (see [27, 34]. Inspired by sustainability transition research, we conceptualize cycling as a socio-material system co-constituted by both material (e.g., built infrastructure, topography, transport modes) and social elements (e.g., people, institutions, norms and regulation) [26, 38]. We are particularly interested in how transitions research represents the material (hard) and social (soft) elements of cycling, as well as how and by whom the socio-material system ought to change to advance cycling.

Numerous literature reviews on cycling have previously been undertaken. Earlier reviews have collated knowledge on the utility aspects of cycling, where for example commuting practices have been a dominating focus [20, 30]. Various programs, policies and instruments to support cycling have been analyzed [3, 32]. Additional reviews have investigated cyclists' safety in sharing road space with motorized vehicles [46] and means of making cycling more accessible through bicycle infrastructure, such as bikeway networks [11], or bicycle parking [31]. Previous reviews have furthermore shown an increased interested in 'smart' cycling innovations, such as bikeshare systems (BSS) [24], e-bikes [1] and data-driven approaches to inform transport planning and design [29].

While there are known measures positively correlating with increased cycling, few reviews explore how increased cycling could be initiated and managed beyond individual projects or technologies [32, 48, 74]. While existing reviews indirectly touch upon different dimensions of cycling governance, none focus solely on cycling governance in urban contexts. This is despite wide academic consensus that it is particularly in urban environments, where cycling can play out its advantages over motorized individual transport [49]. Ryghaug et al. [52] recently argued for the benefits of accentuating Social Science and Humanities perspectives in transport and mobility research to support policy and planning. We see our study responding to their call for realizing quicker and more just transitions towards environmentally benign, low-carbon transport and mobility. In reviewing scholarly research outputs, we acknowledge the importance of knowledge production in representing and envisioning (future) mobility systems. Our focus on urban cycling contributes to discourses challenging "dominant mobility regimes and car dependency" [52], p.761). Heuristically, our focus on the governance of cycling, foregrounds the necessity of better understanding and adapting governance constellations and the processes they engender or inhibit. It is our ambition to analyze dominant representations of the socio-material system constituting cycling in urban spaces, and to identify gaps and blind spots that need further inquiry. With this article we seek to stimulate critical reflection on how

sustainability transitions research might expand the scientific visions of cycling in future transport systems, and contribute to a more transformative cycling governance in urban spaces.

In the following section we present the methodology, introducing the analytical framework and methods for this review. This is followed by a presentation of our results where we unpack the 'what', 'who' and 'how' of cycling in transitions research. In the final conclusion and discussion we reflect on the implications of our findings in relation to sustainability transitions research and for cycling governance more generally.

2 Methodology
2.1 Analytical framework
Transitions research commonly portrays transport systems as constellations of tangible and intangible elements that form complex interactions. Examples include the connections between people, transport modes, built infrastructure, topographical and geographical landscape features, rules and regulation, values and norms [5, 26]. These co-constituting effects are largely referred to as, 'socio-technical', 'technological innovation' or 'socio-material' systems. For example, in their review on transport research and climate change mitigation Schwanen et al., ([55] p. 994) suggest that common elements in transport systems include: "transport technologies, the price or commodity value of carbon, the 'hard' infrastructure, the 'soft' psyche and behaviour of users, and the institutions governing transport systems".

Apart from identifying the hard and soft elements of the system that transition scholars focus on when researching cycling mobility, transition scholars typically portray transitions as processes involving several actors, relating to each other in a myriad of ways, and affect or are affected by actions or events in different ways [2]. However, transitions literature has been critiqued for (over)emphasizing the role of incumbent actor groups [38], which risks reproducing existing actor categories as well as underlying power relations [2]. Against this background, it is important to critically interrogate the individual and collective actors included in cycling research, as it shapes how cycling governance is envisioned and enacted. Attending to actors helps approximate who is seen and not seen as affecting, or designing change in the realm of urban cycling (such as, transport engineers, planners, policymakers, and decision-makers more broadly), and who is affected by this change as a potential user of a cycling innovation (the broad public) [50].

Taking this critique of transition studies into account, and for illuminating how cycling is made an object of governance, materially and socially, we took inspiration from the analytical framework developed by [69–71].

Developed and applied to disentangle how structure and agency are represented in the context of back casting scenarios, the analytical frameworks focus on and helps distinguish between objects of change (what will change?), agents of change (who will make change happen?) and measures of change (how will change be brought about?). These analytical questions have guided our review, and helped capture dominant representations of cycling and cycling governance in transitions research.

2.2 Material & methods

The literature review follows the process steps of screening, scoping and assessment [7]. The steps aim at being overt and consistent, collectively adhering to systematic literature review approaches [7]. Three aspects informed the search syntax we applied to the databases, 'cycle', 'urban' and 'transition'. We used both Scopus and Web of Science databases to search for peer-reviewed scientific publications in English [9, 31]. We tested synonyms for the three themes, as well as Boolean operators and truncations to increase the amount of obtainable results. We started from a baseline search string — *(cycl* OR bicycl* OR bik*) AND (urban OR city OR town) AND (transition)*. Related terms and synonyms were subsequently introduced to the two thematic groups *'cycle'* and *'urban'*. While the terms 'transition' and 'transformation' are often used interchangeably, they invoke different system conceptualizations, they also tend to have different analytical foci, and are frequently affiliated with different strands of research [34]. While this omission limits the scope of our review, we achieved higher precision in our search, leading to more comparable search results. The sequenced search process allowed us to evaluate the impact of individual search terms on the number of obtainable results and furthermore enabled a more transparent and reproducible screening process. Including and testing new search terms provided the final search string:

(cycl* OR bicycl* OR bik* OR "active commut*" OR velo* OR e-bi* OR e-cycl* OR "elect* cycl*" OR "elect* bicycl*" OR "active transport*" OR "active mobilit*" OR "sustainable mobilit*" OR "sustainable transport*" OR "sustainable commut*") AND (urban OR city OR cities OR town OR metropoli* OR municipal* OR borough* OR neighborhood OR conurbation OR suburb* OR downtown OR exurb OR midtown) AND (transitio).

The search process began in autumn, 2018 and continued until summer, 2022. We obtained a total of 3133 publications that we assessed in two stages (see Fig. 1). We oriented our analytical approach and its depiction at the PRISMA 2020 guidelines [43], which provides "a standard for the reporting of systematic reviews and meta-analyses in the published journal literature [...]." [7], p.311). During a first screening round, the lead author

read titles and abstracts of the search results. No strict exclusion criteria regarding sources, document or study type where applied in this process step so that no potentially relevant articles were excluded for citation screening or as background material for this study. We included articles that showed a potential sustainability transitions framing, referred to cycling or related innovations, and position the study in an urban context. The first assessment stage resulted in 110 peer-reviewed original articles that explicitly introduce the field of sustainability transitions in the introductory, or background section, relate to transitions approaches as heuristic frameworks, and discuss results in a context of sustainability transitions. Of these 110 articles, 17 studies fit all inclusion criteria. We furthermore traced the references of the 17 studies and set up search alerts in Scopus and Web of Science, which resulted in 8 additional studies eligible for inclusion. Subsequently, 25 articles met all inclusion criteria and remained for synthesis and analysis.

The articles selected were coded manually and thematically by the lead author using the analytical questions as a framework [7], i.e. what will change? Who will make change happen? How will change be brought about? Since the analyzed articles included descriptions of diverse factors, measures and actors impacting cycling in given cases, we present the dominant themes foregrounded in each article. These dominant themes were deduced by close reading of abstracts, research questions, aims and/or objectives, results and conclusions of each article. As an illustration, objects of change (what) comprise various cycling technologies, such as e-bikes and bikeshare technologies. These cycling objects introduce, or facilitate, particular cycling practices. Compared to cycling objects -which relate to a particular cycling activity- measures (how) appear more broadly formulated, and not directly tied to specific objects nor cycling practices. The actors (who) refer to both general groups relevant to cycling or cycling developments (e.g., NGOs, public authorities, marginalized groups) and groups explicitly identified as being significant to individual case studies. Describing cycling activities and measures to enhance cycling invariably implies mentioning the cyclist, or who is involved in development, implementation and management of cycling measures, for this reason we have integrated the question of 'who' in the presentation of objects and measures.

3 Unpacking the 'what', 'who' and 'how' of cycling in transitions research

3.1 Overview – theories and empirical contexts

Our analysis shows how application of transitions theories have differed and developed over time. Prior to 2015 we see a phase of testing transitions approaches

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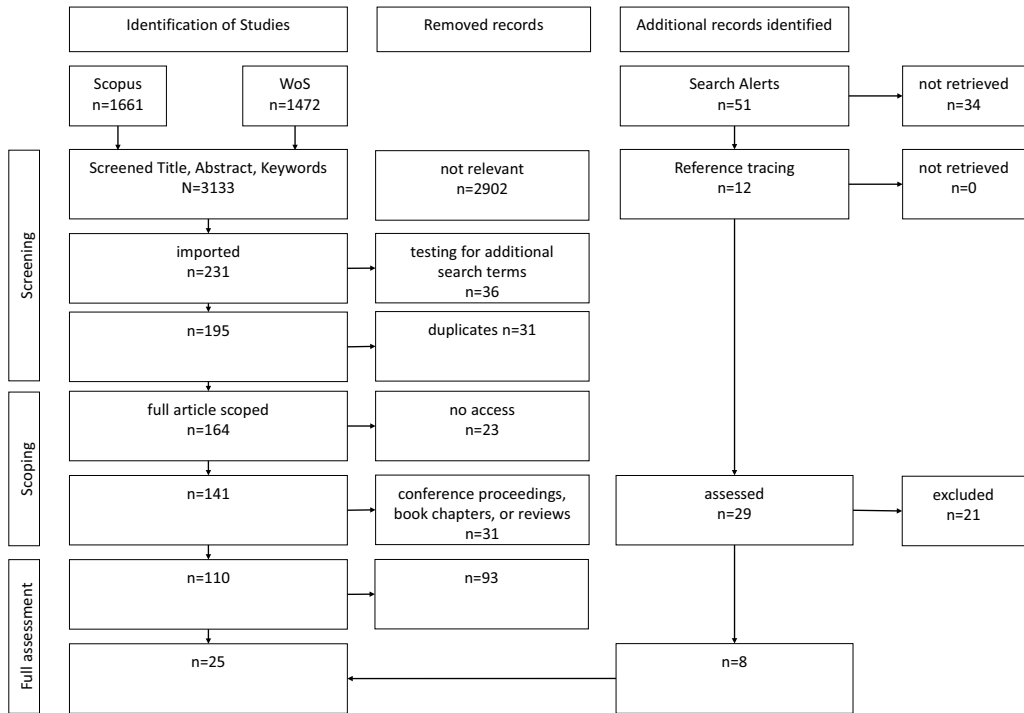
Fig. 1 Review process flow chart

on cycling and transport in general. Several authors explicitly test the applicability of transitions theories on transport and mobility as objectives of their studies [4, 73]. The multi-level perspective (MLP) [25, 51] appears synonymous with transition frameworks, with many of the authors referencing the MLP early on in their study, or using it to explain transitions. The MLP is the most prominent heuristic applied either explicitly [16], Ó[66] or in an adapted form [13, 39, 40]. The MLP is frequently modified by incorporating other heuristics, concepts, frameworks, or theories,including notions of justice [44] or spatial scales [73]. Apart from the MLP, adaptations to Strategic Niche Management (SNM) [8], the Technological Innovation System (TIS), and Social Practice Theory [12] can be observed in the literature. The studies furthermore commonly draw on theoretical and conceptual notions that informed the development of transitions theories, such as Science and Technology Studies (STS), Innovation Studies and Evolutionary Economics [38]. Vreugdenhil & Williams [68] provide the earliest example of the reviewed studies using not an explicit theory, but a broader socio-technical notion. Despite the spread of

different theoretical tenets, all the reviewed studies share an understanding that cycling is embedded in a system consisting of material elements and non-material relations, and that cycling is in a struggle against persistent transport system elements of motorized personal transport.

So, in what contexts is transitions research on cycling located? Given this study's focus on urban cycling, the boundaries of the functional system of transport largely coincide with the administrative boundaries of the urban areas. However, several studies incorporate notions of vertical governance relations drawing connections to superordinate regional or national administrative levels [4, 39, 40, 56]. Culture, topography, climate, administrative systems, urban layout and infrastructure, all affect the status of cycling and its prospective role in urban mobility systems. While the studies presented in our review reflect this diversity, there is a trend towards case city selections centered on Europe, with a strong focus on Copenhagen and Amsterdam. This is followed by studies from China [39, 40, 73, 73], South and South-East Asia [4, 56, 57, 61] and a single study from Istanbul. In most cases

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the best practice examples of Amsterdam and Copenhagen are mentioned and often explicitly used as benchmarks for comparison, or as providing learning potential for cities with a low cycling mode share (e.g., [16, 28]).

In the following subsections, we present key findings according to the analytical framework. Table 1 presents the characteristics of the 25 included studies, categorized by the empirical cycling object that is foregrounded in the respective studies and the measures for change.

3.2 The 'what' of cycling

Throughout the reviewed articles, cycling objects are the points of interventions for cycling-promoting measures, providing a material anchor to which alternative cycling activities are enabled in urban transport systems. Moreover, given the origins of sustainability transitions in Innovation Studies and STS, it comes as no surprise that the articles reviewed tend to emphasize technological innovations. Two particular cycling objects are dominant, namely electric bikes (e-bikes) and bike-sharing systems (BSS).

E-bikes are generally portrayed as an important technological innovation to enhance cycling levels. The earliest studies into e-bikes explore their emergence in Chinese cities. Lin, Wells and Sovacool [39, 40], examining Beijing, Tianjin, Shanghai and Nanjing to understand the status of the e-bike in Chinese mobility systems, as well as its future prospects as part of China's urban mobility systems. Lin et al., [39, 40] use survey data to investigate and estimate e-bike adoption and mode choice, where non-users, potential users and users of e-bikes are considered the most central groups to influence the uptake and use of e-bikes. In contrast, Wells and Lin [73] take a more exploratory approach, uncovering processes that lead to the rapid growth of e-biking in Chinese cities. The authors emphasize the 'spontaneous emergence' of e-bikes in the absence of governmental support, leaving local authorities scrambling to post-regulate e-bike technology to mitigate unsafe and disruptive cycling practices. There are clear connections between Wells and Lin [73] and the BSS cases introduced below, where market actors were crucial in driving the introduction of a cycling-technology in a comparably short time. The Chinese case studies conclude that e-bikes are unlikely to become a permanent addition to the urban mobility mix, or have any considerable impact on transitions towards sustainable urban transport due to the continued high demand and planning for automobility [39, 40, 73]. In a Canadian context, Edge and colleagues [19] present a role for e-bikes different to the Chinese cases. In investigating stakeholders' perception of e-bikes and their potential in transitioning Toronto's urban mobility system, the authors reveal the potential for e-bikes to replace cars and become integrated in a low-carbon system of mobility together with public transit. This transition is seen as being reliant on enhanced policy coordination, support, and regulation of e-bike use [19].

BSS is another technological innovation in the transitions' literature reviewed that serves as a point of interventions. Bikesharing is, however, not a new phenomenon. Since its introduction in the Netherlands in the 1960s [17, 24], new actors, technologies, and business models have diversified the provision of shared cycling. In general, articles focus on BSS from a *technological, innovation* or *public–private partnership* perspective, which direct attention towards different groups of actors and measures. As a technology, BSS is commonly differentiated according to the infrastructure requirements of the systems, technologies, and the flexibility they provide for pick-up and drop-off. For example, station-based systems require docking stations distributed across the city, where bikes can be collected and returned. In the earliest studies on BSS in this review, Ó Tuama [66] provides a positive example of bikesharing technologies using station-based sharing system in Dublin as a case. By applying the MLP heuristic Ó Tuama shows how the introduction of dublinbikes led to knock-on effects that changed Dublin's wider socio-technical transport system. As with earlier station-based sharing applications in the Netherlands [67], public actors sought to tailor the project to the local context that led Dubliners, many with limited experience of cycling in the city, to embrace the service. Dublinbikes introduced traditionally non-cycling groups to experience the city from the saddle, inspiring reflection on the inadequate cycling infrastructure, which in turn is argued to have further strengthened cycling advocacy efforts. Ó Tuama [66] exemplifies how the introduction of an innovative cycling technology can lead to users and advocacies seeking to advance cycling more generally.

ICT and the ubiquitous use of smartphones, has enabled free-floating, or dockless systems to become more prevalent. For example, in the low-cycling context of Santiago, Saud and Thomopoulos [53] argue for novel data analysis and visualization tools for sharing providers to expand and optimize their sharing schemes. But bikesharing technologies are not unproblematic. Tan and Du [63] exemplify the effects of rapid implementation of dockless sharing systems in Guangzhu, China, where private sharing providers, backed by extensive capital, flooded the urban mobility systems with their dockless service that were not considered in governmental land-use regulation.

In recent years, there has been an increased interest in bikesharing systems as innovations within motorized transport systems. In the low-cycling share global South

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Table 1 Overview of reviewed studies

Authors and publication year	Study title	Aims	Objectives	Emphasized actors (Who)
Cycling Objects (What)				
E-bikes				
[19]	Shifting gears on sustainable transport transitions: Stakeholder perspectives on e-bikes in Toronto, Canada	Explore how governance actors in the transport system perceive e-bikes	- Explore how governance stakeholders see the role of e-bikes in sustainability transitions - Explore their role in uptake or rejection of the technology	Transportation governance actors ("strategic policy development, regulation, enforcement and infrastructure management in the City of Toronto, Canada") pp.199–200
[39]	Benign mobility? Electric bicycles, sustainable transport consumption behaviour and socio-technical transitions in Nanjing, China	Analyze the role of e-bike use in the urban transport system of Nanjing	Analyse "attitudes and characteristics" (p.224) of residents towards e-bike use	(Potential) users and other mode users directly addressed through survey
[40]	The death of a transport regime? The future of electric bicycles and transportation pathways for sustainable mobility in China	- Describe the future development of e-bikes in China - Apply the MLP to transport systems	- Identify factors that will influence the further adoption of e-bikes - Analyse how e-bikes compare to other modes of transport - Predict whether e-bikes will consolidate their role in the transport system, or not	(Potential) users and other mode users directly addressed through survey
[73]	Spontaneous emergence versus technology management in sustainable mobility transitions: Electric bicycles in China	Explore reasons and mechanisms behind the rise of e-bikes in China	- Analyze why e-bike emerged in absence of active policy support in China - Multi-scalar MLP application to explain change processes in the e-bike market	Market and policy-actors
Bikeshare systems (BSS)				
[53]	Towards inclusive transport landscapes: Re-visualizing a Bicycle Sharing Scheme in Santiago Metropolitan Region	- Analyze the implications of introducing a BSS in its social and institutional dimensions - Introduce a new tool for managing BSS in a Global South context	Combining the MLP with alluvial diagrams and circular dendrograms to inform transport planning and operation of BSS	- Focus on local authorities (comunas), but also public and private transport planners and policy-makers - Undifferentiated users that provide data for improving services (BSS-users compared to other public space users)
[63]	The Governance Challenge within Socio-Technical Transition Processes: Public Bicycles and Smartphone-Based Bicycles in Guangzhou, China	Analyse how technological transport innovations affect modes of urban governance	Explore the effects of change from public bikes to technology- enhanced sharing systems had on mobility governance in Guangzhou, China	o
[60]	Bicycle Policy in Mexico City: Urban Experiments and Differentiated Citizenship	Examine how bicycle policy (sustainable transport innovation) affects urban citizenship unequally in different parts of Mexico City	Apply a "Cities and Low carbon Transitions framework" [21] to evaluate and conceptualize urban transport as a socio-technical system - Introduce urban citizenship concepts to emphasize how cycling infrastructure affects inequality [33]	Policy-actors: BSS-firms, urban administrators, NGOs and advocates

Table 1 (continued)

Authors and publication year	Study title	Aims	Objectives	Emphasized actors (Who)
[61]	Social enterprise as catalyst of transformation in the micro-mobility sector	- Introduce social entrepreneurship to sustainability transitions research - How social enterprises as innovations interact with the existing socio-technical transport regime	Describe how a local University bikeshare scheme grew to become the first established bikeshare operator in Manila	Social entrepreneurs, volunteer community around it and advocacies
[57]	Policy, users and discourses: Examples from bikeshare programs in (Kolkata) India and (Manila) Philippines	Examine how cycling transitions play out in Manila and Kalkota with a focus on bikeshare schemes (PEDL, Kolkata & UPBS, Manila)	Investigate the dynamics in changing administrative regulations and the role of bikeshare users through a novel transitions framework focusing on administrative and socio-institutional practices mediated by user roles and discourses (political, cultural and smart)	Based on (Schot et al., 2016) users are: - producer of new practices, legitimators of visions and aspirations - intermediaries shaping and (re-)aligning systems' elements - citizens becoming active in challenging existing regimes, while nurturing and protecting the niche, and - consumers who purchase the cycling service
[18]	The Dynamics of Public Participation in New Technology Transitions: The Case of Dockless Bicycle Hire in Manchester	Examine how and why an innovation (local BSS) failed in Manchester	Understand the political and public implications of a niche innovation	Local public authorities, bikeshare provider, the public as end-users, particularly young people
[45]	Dockless bikeshare in Amsterdam: a mobility justice perspective on niche framing struggles	Analyse bikeshare actors attempts towards legitimization	Integration of mobility justice and socio-technical transitions concepts	Bikeshare providers, researchers supporting sharing economy (niche) city government, conventional BSS providers, NGOs, researchers wary of the sharing economy, organized residents
[66]	Ripples through the city: Understanding the processes set in motion through embedding a public bike sharing scheme in a city	Explore the effects of introducing a public bikeshare scheme (dublinbikes) to an urban system	Apply a MLP to map the existing socio-technical transport system and the disruptive and reconfiguring effects of the bike-share scheme after break-through	Cycling advocacies, users
[67]	Business model innovation and socio-technical transitions. A new prospective framework with an application to bike sharing	Develop a prospective transition framework	Investigate potential for various bikeshare providers' business models to grow (scale) based on increasing returns, industry structure around the innovation and the institutional context	bikeshare providers, industry and public institutions
Measures addressing cycling (How)				
Infrastructural interventions				
[22]	Encountering bikelash: Experiences and lessons from New Zealand communities	To investigate organized, community-level, opposition to bike lanes (bikelash)	- What are the motivations for bikelash? - What are the experiences of supporters (e.g. local council and transport agency planners) and opponents (e.g. conservative community members and local retailers)? - What are the responses to bikelash?	Supporters and opponents of bicycle infrastructure

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Table 1 (continued)

Authors and publication year	Study title	Aims	Objectives	Emphasized actors (Who)
[68]	White line fever: a sociotechnical perspective on the contested implementation of an urban bike lane network	Develop a ST-systems perspective to capture dynamics of social and technical elements	- Investigate how the bike networked developed after implementation - Explore how bike lane implementation affected the urban transport system	o
Policy and planning (innovation)				
[8]	The challenge of the bicycle street: Applying collaborative governance processes while protecting user centred innovations	Explore how collaborative governance affects SNMP exemplified through the bicycle street as a policy innovation	- Describe how bicycle streets originated and developed in Germany, Belgium and the Netherlands to protect cycling practices - describe challenges of collaborative governance and protecting practices through a case of a bicycle street in Eindhoven	o
[44]	The legal street: a scarcity approach to urban open space in mobility transitions	Identify and compare spatial allocation and appropriation by bicycles and cars and how they affect sustainable mobility transitions	- Identify regulations for space allocations - Identify practices for appropriating space - Explore the implications on mobility transitions	o
[36]	Reinventing the bicycle: how calculative practices shape urban environmental governance	Explore how novel knowledge-producing practices affect how cycling is known, made visible and governed	Analyse how calculative devices (a form of epistemic practice, such as accident statistics, or cost-benefit analysis) were used to understand and and act upon cycling in Copenhagen since the 1900s	Urban planners as main users of calculative devices
[28]	Urban transport transitions: Copenhagen, City of Cyclists	Derive insights from Copenhagen's bicycle strategy by assessing in which aspects it has worked (success), where it didn't work (limitations), and the reproducibility of the strategy	Investigate the role of market-based, soft policy and command-and-control measures since the 2000s to advance cycling in Copenhagen	o
Comprehensive systems perspective				
[58]	Policy learning and sustainable urban transitions: Mobilising Berlin's cycling renaissance	Explore a proposed learning relationship on cycling policy	- Multi-actor analysis to understand the role of policy in Berlin's cycling increase - Analysis of Manchester's policies and interviews with planning and policy actors to understand the adoption of Berlin's model	o
[4]	Hot or not? The role of cycling in ASEAN megacities: Case studies of Bangkok and Manila	Apply TIS-approach to cycling	- Describe cycling in Bangkok and Manila (status-quo and advances) - Describe necessary steps to develop cycling's role in the transport systems - test TIS-framework on sustainable transport	Policy-makers (as this is the take-away of the TIS-framework

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Table 1 (continued)

Authors and publication year	Study title	Aims	Objectives	Emphasized actors (Who)
[13]	A socio-technical transition framework for introducing cycling in developing megacities: The case of Istanbul	Introduce a framework to facilitate transitions towards cycling in developing Megacities where cycling is marginalized	- Apply the MLP to Istanbul's ST-transport system around cycling - Suggest pathways for cycling transitions in Istanbul	(potential) cyclists and "experts" (urban or transport planners, engineers and public administrators
[56]	Cycling the city, re-imagining the city: Envisioning urban sustainability transitions in Thailand	Demonstrating the relevance of urban imaginaries' envisioned by 'change agents' to prefigure the context of urban sustainability transitions	Describe how urban imaginaries emerge, gain substance, are communicated and mobilized	Cycling campaigners
[16]	Getting Londoners on two wheels: A comparative approach analysing London's potential pathways to cycling transitions	Identify pathways and barriers to upscaling of London's cycling niche	Compare historical cycling transitions in Amsterdam with the current status of cycling in London	Policy-makers, advocacies and cyclists
[12]	Bicycle commuting in an automobile-dominated city: how individuals become and remain bike commuters in Charlotte, North Carolina	To better understand how bike commuting is adopted and maintained	Elicit bike commuting practices in Charlotte based on commuters' first-hand accounts	Experienced and novice cyclists, officials, planners and employers

contexts of Asia and the Americas [53, 60, 61, 63], BSS are commonly framed as niches within transport systems dominated by motorized individual transport. This contrasts with the situation in cities with high cycling levels, such as Amsterdam, where sharing systems compete with individual 'traditional' cycling. Where different sharing systems are available, BSS compete with each other in its own niche of transport. Another take on innovation is provided by van Waes and colleagues [67]. In their study on sharing providers, the authors position bike sharing business models, rather than the bike sharing technology, as the innovative element. Departing from Dutch city contexts, the authors assess various sharing business models and suggest that their potential to scale up hinges on the models as such, but also the industry structure of sharing providers, the alignment or friction with formal and informal institutions, and the potential for increasing returns on investment [67]. Another type of studies approaching bikesharing models as innovation address the effect of non-profit organization entering the mobility market from outside. Sunio et al. [61] show how social entrepreneurs, in Manila, succeeded in addressing local mobility needs by creating their own niche through developing a sharing scheme at a University. The study argues for the alignment of narratives and collaboration with advocacy organization to benefit from established sustainability-oriented advocacy efforts. The case adds weight to the roles of grassroots initiatives and social enterprises for furthering cycling services in the maturing cycling context of the global South. Bikesharing business models have also been addressed from discursive perspectives. In their analysis of mobility niches in Amsterdam, Petzer, Wieczorek and Verbong [45] emphasize the discursive struggles between bikesharing advocates and their opponents. Opponents want to protect the existing cycling culture, while sharing advocates try to break out of the cycling mobility niche. The authors find that cycling proponents struggle against motorized modes of transport traditionally supported by planning systems. It is particularly difficult to negotiate which kind of bikesharing should be prioritized, and to demonstrate how different sharing models cater to different user groups.

An additional type of study concentrates on the relationships between public and private actors in BSS. In the Netherlands station-based cycling for commuters is favored, having become institutionally embedded through long-standing collaborations between transport providers and local public actors. Sosa López in Mexico City [60], Sharmeen et al. in Kolkata and Manila [57] and Dudley et al. in Manchester [18] emphasize the role of BSS users and public authorities in mobility transitions. Though in different contexts, the three cases underline

the importance of attuning BSS to local circumstances and involving the public at an early stage in order to adapt the BSS according to local contexts and needs to avoid marginalizing actors. For example, in a case study of Mexico City's bicycle policy, Sosa Lopéz [60] shows how the Ecobici bicycle sharing system exacerbated mobility injustices. The close collaboration between city authorities and profit-oriented bikesharing providers meant that the sharing system failed to address local mobility needs. City authorities prioritized quick roll-out of the sharing scheme, rather than adhering to a collaborative process in the project's planning and implementation, which meant that Ecobici was located in affluent parts of the city, excluding those most dependent on bicycle mobility.

In summary, we found that E-bikes and BSS are the most common cycling-technologies presented as cycling objects. Both technologies that diversify cycling practices and provide potentially new demographics access to cycling. E-bikes extend cycling ranges and promise less effort in cycling to also increase cycling for transport and logistics. BSS are mostly positioned as part of short, multi-modal trips for commuters and visitors. For e-bikes and bike sharing, the reviewed studies commonly describe a struggle of embedding the technologies in urban transport systems. In addition to 'normal' cycling's challenges in auto-dominated urban systems, particularly regulatory barriers constrain their entry and spread. E-bikes do not fit into existing transport regulation and their potential to replace carbon-intensive travel modes is uncertain. The successful implementation of sharing systems relies on early and close collaboration of sharing-providers with public authorities to avoid land-use conflicts over limited urban space. Even when successfully launched, operation and maintenance pose further challenges, such as profitability, rebalancing bicycle fleets, vandalism and wild parking. Particularly sharing systems feed into smart city scenarios, where they generate valuable data and make use of smart technology for comfortable and convenient use.

3.3 Measures addressing cycling—The 'how' of enhanced cycling mobility

In this section, we elaborate on the measures represented as enabling or hampering cycling levels in urban contexts. In our review, we identify three types of measures recurring in the literature, namely: *physical infrastructural interventions*; *public policy and planning (innovation)*; and, what we refer to as a *comprehensive systems perspective*. The latter theme refers to articles broadly interested in mapping out and understanding cycling's status and/or potential in urban systems.

We identified two articles highlighting the effects of introducing *physical infrastructural interventions* to

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support cycling in the low-cycling contexts of New Zealand [22] and Australia [68]. The provision of cycling infrastructure separating cycling from motorized transport is commonly seen as a crucial cycling-supporting element. Jointly, the two articles exemplify that even minor interventions, such as painted bike lanes, can lead to adverse community responses that need to be anticipated and accounted for. Both articles point towards the importance of strong political leadership and adjusting established planning and governance processes to implement cycling measures challenging the status-quo of embedded and accepted car-oriented systems. Vreugdenhil and Williams [68] provide the first conceptualization of cycling as a sociotechnical system in our analysis. The authors develop the argument that the material introduction of bike lanes can lead to far-reaching local opposition. In a similar vein, but utilizing an actor-oriented approach, Field and colleagues [22] investigate the motivations for "bikelash" (backlash against bike lanes) and identify that coalition-building around community concerns beyond the minimum planning requirements of information and participation are essential to reconstructing bike lane opponents' perceptions of cycling-supporting interventions.

Another set of measures include *public policy and planning innovation*. Petzer, Wieczorek and Verbong [44] introduce an innovative heuristic, 'legal streets framework', to reconceive urban open space through formal allocation processes, scripted through urban transport policies and informal appropriation practices. By applying the legal streets framework on Amsterdam, the authors show how restricting spaces for parking and driving cars freed up spaced for cycling and walking. In aspiring cycling context (e.g., Brussels, Birmingham), the authors suggest that the "legal streets framework" can assist local authorities to pursue and actively reduce automobile space even when regional, national and supranational governance marginalize pro-cycling policies. With the ambition to rethink public mobility policy and behavior, Jensen, Cashmore and Elle [36] direct attention to the role of knowledge-producing practices in how cycling is conceptualized. Using Copenhagen as a case, the authors demonstrate how the use of cycle accident statistics, regular assessment of the city's cycling status and cycling-support measures and quantifying the monetary benefits of cycling, created argumentative support and accountability in public cycling policy. Combined, these interventions contributed to the city's current status as a leading cycling city. Petzer and colleagues [44] provide an innovative way of using existing policy frameworks, while Jensen et al. [36] present new policy measures. In contrast, Gössling [28] comprehensively evaluates Copenhagen's existing transport policies to derive which policy mix has led to the city's high cycling rates. Success in cycling promotion since the early 2000s, is argued to be grounded in a mix of market-based, soft-policy and command-and-control measures that led to Copenhagen's unique cycling status. Other studies note that the importance of consultation and consensus-oriented collaborative processes can be overemphasized, and that collaborative processes alone cannot replace enforceable regulation on motorized traffic [8].

In contrast to measures targeting *physical infrastructure, public policy and planning innovation,* the articles categorized as *comprehensive systems perspective* are typically exploratory in scope. Instead of departing from predefined actor groups, scales, and policy boundaries these articles investigate how existing transport systems' elements and configurations, pose barriers, or present opportunities for cycling practices to develop. An exception are Caldwell and Boyer [12], who are specific about the cyclist group and cycling practice they investigate in that they seek to understand how cycling commuters adopt and maintain cycling to work. In comparison, an example for a more open, exploratory approach is provided by Bakker and colleagues [4], who present a study of Bangkok's and Manila's current cycling status in the transport system, where they identify and assess the potential of different system components (e.g., actors, networks, institutions) as a means to increase cycling levels. The authors identify a diversity of actors relevant to cycling governance, including utility and recreational cyclists, local and national policy makers, advocacy organizations, media outlets, local bike shops, cycling industry, police, etc. In an analysis of cycling's role in Istanbul's transport system, Canitez [13] suggest that cycling issues need to be vertically supported from national down to city levels, and horizontally integrated into policy areas beyond transport, such as environmental and land-use policy. Canitez [13] argues that urban and transport planners, engineers and public administrators need to move beyond the technological focus on built infrastructure for cycling, and engage with the social aspects of cycling. In particular the narrow understanding of cycling as a recreational activity for men, which is subordinated to automobility [13]. In a similar vein, de Boer and Caprotti [16] argue that the social representation of cyclists and cycling in London must become wider. Inspired by Amsterdam's historic success in advancing cycling, de Boer and Caprotti [16] investigate the potential of a similar transition taking place in London. Apart from identifying regime actors, such as public authorities, policy-makers, transport engineers and advocacies as the main drivers of radical transformations, the authors note how cycling in London was dominated by a homogenous group of dedicated young, male

cyclists. As well as suggesting "carrot and stick" policies to restrict car accessibility and parking (e.g., through congestion charges), and designated cycling infrastructure to make cycling more attractive and competitive with other transport modes, De Boer and Caprotti ([16], p.624) argue that cycling needs a broader representation to become more inclusive and widely recognized as a "practical transport mode".

In addition to expanding social representations of possible cyclists, Sengers [56] draws attention to the agency of particular groups of actors in cycling transitions. Using Thailand as a case, Sengers [56] explores the role of cycling advocates and the visions for cycling they convey through their work. The author describes cycling campaigners as "change agents", crucial for imagining and proliferating alternative cycling futures for the country. Lastly, Sheldrick, Evans and Schliwa [58] describe how cycling transitions are highly contextual and cannot easily be copied. Manchester, to secure funding for urban transport projects, entered a cooperation with Berlin to learn from their recent success in advancing cycling. The authors suggest that Manchester simplified and reframed complex socio-technical processes that led to increased cycling in Berlin. Instead, Manchester presented Berlin's pro-cycling success as strategic and policy driven. In contrast, the authors argue, the main impetus for increased cycling levels in Berlin derived from inhabitants' recognition that the urban setting, predominantly broad roads and dense service provision in neighbourhoods provides physical preconditions conducive to cycling.

Our review shows that the 'how' of cycling is concerned with the modalities of increasing cycling practices. Not necessarily new ideas, but seen in new ways as part of intervening in the social and material fabric of the city, cycling measures uncover new problems and opportunities for increased cycling. Old topics such as context sensitivity are revamped, with 'novelty' or 'innovation' depending on where certain interventions take place. Practical examples of completely new ways of constructing cycling and related issues reimagine the construction of cycling policies, programs and instruments. Under the theme 'comprehensive systems perspective', the benefits of transitions frameworks come to the fore in that they provide analytical heuristics to explore cycling conditions systemically.

4 Concluding discussion
In this review, we have aimed to unpack dominant representations of urban cycling in transition studies regarding cycling activities, the main actors, and the measures focused on in the literature. In the following, we summarize key findings, gaps and blind spots, and discuss the results in relation to the wider transitions literature to identify avenues for future cycling research.

4.1 Actors' roles in transitions towards increased cycling
In performing the practice of cycling, cyclists are probably the most important actors in cycling governance [8]. Although this review reflects a growing engagement with urban cycling in transitions research, and a great diversity regarding useful frameworks, as well as geographical, temporal and empirical foci, the actor groups highlighted in most studies are remarkably consistent. For example, independent of geographic context, actors involved in cycling transitions appear to be e.g. local public authorities, policy-makers and planners together with technology providers. The distinction between actor categories is often blurred, with different actors collaborating in different ways to implement and manage, for instance, e-bikes or BSS. As the two Oceania bike lane cases reveal [22, 68], best practice in one context does not imply direct transferability into other contexts. Local communities play an important role in accepting cycling infrastructure and adopting cycling practices. It is plausible to assume that important actors may be overlooked if the identifications of actors and their roles in cycling transitions are based on predefined categories, or if their roles and relations are unspecified. Another blind spot is the interactions of actors, which may hold an important role in shaping cycling. Generally, it remains rather unclear what roles (potential) cycling practitioners and diverse cycling practices might play in transforming urban mobility systems. Against this background, sustainability transitions research on cycling would benefit from more clarity on what it is that should be governed (vélomobility and/or people who cycle), who is and who could or should govern (public authorities, advocacy organizations, public institutions/or practitioners, citizens), through which measures and towards what end.

4.2 Reflections on applications of transitions frameworks to urban cycling
The reviewed articles might not push the theoretical vanguard, but they do provide important contributions in testing and applying transitions frameworks to cycling. In addition, through reliance on qualitative methods transitions research softens the divide between traditionally positivistic transport studies and mobilities research. Transitions literature confronts us with the obduracy of urban systems. With few exceptions, the built environment manifests in car-centered transport systems that are difficult to change. The studies we analyzed in this review, challenge car-oriented planning, requiring planners and policy makers to broaden the vision for alternative transport and mobility futures. The academic community is

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well equipped to make important theoretical, empirical and policy-relevant contributions for advancing cycling, such as new ways of seeing and knowing urban space and cycling's role in it (e.g., [36, 44]).

Our results demonstrate that cycling research in transition studies has an empirical focus on two dominant objects: e-bikes and bikesharing systems. While innovative cycling technologies are in focus, less attention is paid to more traditional mundane cycling activities, which still have an important transformative role to play, particularly in low-cycling contexts [49, 72]. The large share of research on technological and economic aspects of cycling reflects a reproduction of ecomodernist ideas, with technological substitution essential for transitions. The representations of actors and measures are largely structured in line with e-bikes and BSS, by which public actors and private businesses can boost cycling levels. This framing furthermore suggests that people cycling, or the unspecified broader public, can become 'users' or 'consumers' and cycling a 'product'. Few studies exemplify non-standard cycling-supporting measures (e.g., social entrepreneurship) [57, 61], or that new cycling technology and cycling practices can be implemented in absence of policy support [39, 40, 63, 73].

The expanding engagement with urban cycling in transition studies appears to follow the general trajectory of transitions theories and frameworks, typically including retrospective analyses and status-quo assessments of urban systems in the early stages of application [38]. This is often in combination with investigations of technological or policy innovations (at times combined with conceptual foci on justice and equity) [45]. Similar to this general trajectory, the majority of research we reviewed takes an analytical or evaluative position where the research focus suggests to test or advance transitions theories through extrinsic case studies rather than aiming for fundamental changes of urban mobility, and enhanced cycling levels. Transitions research provides useful lenses to assess the status quo and to guide cycling interventions in urban systems. Yet, cycling issues, let alone their governance, currently form a niche within sustainability transitions research.

In conclusion, our analysis suggests that to date, urban cycling transitions scholarships lacks normative and change-oriented ambitions. Indeed, as with other fields of sustainability-related studies, it might not be researchers' task to *only* provide policy-relevant research, but also to challenge and provide alternative visions for current governance systems of transport and mobility. We consequently recommend scholars to provide an impetus to reframe taken-for-granted assumptions and knowledge about cycling, and explore methods that can help bring sometimes incidental or experimental notions of seeing and knowing cycling to the fore.

4.3 Suggestions for future research

Our results underline a dominant techno-economic focus in transport and mobility research argued to limit transitions towards just and low-carbon mobility systems [52], p.757). We recommend further research to overcome epistemological and ideological lock-ins in both research and practice. Future studies might help eliciting processes of vision-creation and provide practice-relevant tools (e.g. [47]). Imaginaries have previously proven constructive in this regard and might provide inspirations (e.g. [35, 64], see also [56]). To re-imagine alternative mobility and transport futures with cycling as a key means of movement, future research might further seek inspiration from de-and postgrowth scholarship for alternative representations of cycling in relation to well-being and bodily experience (e.g.[15], [62],). This because cycling (together with walking) can provide a low-tech and low-emission archetype of movement that goes against the "techno-economic paradigm" and "neoclassical perspectives of cost minimization dominant in transport research" [52], 757). To strengthen policy relevant knowledge for cycling, we need to consider how cycling is measured and valuated. More research on and for alternative sustainable mobility indicators is needed. Particularly to assess the co-benefits of cycling in relation to motorized individual transport among others based on space use, emissions, mental health (e.g. [6, 59]. Social practice theory has been applied to transport and mobility issues (see [37]) and in dialogue with transitions studies [54, 72]. Practice theory has proven useful in providing policy-applicable recommendations to advance sustainable mobility that warrant future research to further explore it in conjunction with cycling. Finally, given the omission of "transformations" in our study and particularly the urban transitions and transformations research communities having moved closer together in recent years [34, 65], future literature reviews could broaden the scope by including "transformations", potentially in combination with the thematic foci mentioned above.

Author contributions
DV developed the research design, conducted the analysis and synthesis and wrote the paper. JW contributed to developing the introduction, methodology and provided comments and revisions on draft versions of the paper. SH contributed to developing the introduction, presentation of results, discussion and provided comments and revisions on draft versions of the paper.

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Declarations

Competing interests
The authors have no competing interests to declare.

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Publisher's Note

III

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Bike Kitchens and the sociomateriality of practice change: exploring cycling-repair relations

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ABSTRACT

Maintenance and repair of bikes – material interventions – are essential to sustain cycling practices. In this paper we explore the role of (bi)cycle self-repair workshops (Bike Kitchens) and the practices they enable to maintain cycling practices. We connect a sociomaterial understanding of assisted self-repair to Bike Kitchens' role in transformational mobility change. Empirically, we utilize our own experiences in organizing and running a small Bicycle Kitchen in Sweden in conjunctions with observations and interviews, drawing on theories of social practice, the sociology of materiality and repair studies. We develop the position that through deliberate engagement with the cycle as an entity, assisted self-repair practices provide flexible means of representing the transformative potential of cycling materialities. This has implications for the meanings attached to the cycle, cycling, repair and other associated practices. We argue that Bike Kitchens may engender epistemic practices useful to develop human-centered visions for re-imagining mobility and sociomaterial relations.

Introduction

Progress in advancing people-oriented mobility is incremental while at the same time dominance of motorized individual transport continues to grow (European Environment Agency, 2023). Cycling as practices and cycles as technologies are assigned the role of potentially transforming urban mobility away from the automobile (Cox, 2022; Te Brömmelstroet et al., 2022, Spinney, 2016; Spinney, 2022). Yet, how cycling is conceived and governed follows entrenched rationalities of efficiency, speed and utility, strengthening adverse notions of ingrained mobility systems (Cox & Koglin, 2020).

Mobilities scholarship urges a move beyond solutionist approaches of technological substitution (Banister, 2011) and mobility fixes (Spinney, 2020, 2022). Mobilities scholars recognize that new points of intervention are needed to challenge, rather than to reproduce, existing ways of acting on urban systems, mobility (Ryghaug et al. 2022; Te Brömmelstroet et al., 2022) and cycling as a part of it (Cox,

2022). In line with critical and imaginary mobilities, vélomobility scholarship developed as an antithesis to automobility (e.g., Cox, 2019; Koglin, 2013; Furness, 2007). Vélomobility advocates for fundamental change in the rationalities and assumptions underlining mobility, through substantiating people-oriented mobility imaginaries (Cox, 2022). Narrative approaches are argued to hold deep-reaching transformative potential, where mobility might be rethought as play, social interaction, commons and unnecessities (Te Brömmelstroet et al., 2022). In this article we investigate Bike Kitchens as representing an embodied approach to transformative societal change. Bike Kitchens link cycling to material care through convivial characteristics, by enabling mutuality, co-learning and self-sufficiency (Batterbury & Dant, 2019; Batterbury & Manga, 2022; Bradley, 2018; Schmid, 2019; José Zapata Campos et al. 2020).

'Bike Kitchens', 'community bike workshops' or 'DIY bike repair spaces' come in different organizational forms, but are frequently volunteer-run initiatives to support (bi)cycle self-repair and maintenance by providing a space to access tools, spare parts and repair assistance (Batterbury & Dant, 2019; Batterbury & Manga, 2022; Bradley, 2018). In doing so, they offer spaces for social as well as material relations (Batterbury & Vandermeersch, 2016). As part of social movements, Bike Kitchens are conceptualized as 'urban commons' in order to imagine and enact alternative urban futures that resist commodification (Bradley, 2018; Lange & Bürkner, 2018). Instead of economic productivity and efficiency; Bike Kitchens foreground the value of relational goods and volunteering as a 'productive' activity (Fitzpatrick et al., 2022), 'local-regional arenas of "collaborative governance"' (Herrle, 2015: 196 ff. as cited in Lange, 2017: 53) or (forms of 'self-governance', 2020). Some authors argue that in Bikes Kitchens visitors can become change agents in cycling advocacy (Batterbury & Manga, 2022; Rigal, 2023; Furness, 2007).

Previous research on Bike Kitchen and other community initiatives has explored their (potential) roles in (urban) socio-material transformations (Bradley, 2018; Marletto & Sillig, 2019; Seyfang & Haxeltine, 2012). Yet limited research has unpacked *how* Bike Kitchens might engender cycling-centered transformation through the practices enacted within them (for exceptions see e.g. de Chattilon, 2021; Rigal, 2023). Our study departs from Bike Kitchens' practice-material relationship in order to reveal elements to support transformative change. Eco-modern narratives of 'smart cycling' emphasize innovative materiality (e.g. e- or shared cycles), yet the materiality of 'mundane', everyday cycles in cycling practices is rarely addressed (Larsen & Christensen, 2015; Shove, 2012). Many everyday (bi) cycles are in bad shape, with barely functioning brakes, worn out chains and buckled wheels (Larsen, 2017b). While this state of disrepair makes them unobtrusive and less prone to theft, it certainly affects riding quality and at worst can be outright dangerous or a hindrance to cycling. Our study contributes to rethinking the 'ordinary' technologies, such as the cycle, in urban cycling futures. In doing so, we respond to the call that the relation between practices in transport and mobility deserve more consideration, particularly the limited understanding of 'meaning' in social practice (Kent, 2022).

The present study explores how Bike Kitchens engender diverse cycling representations and propagate transformational understandings of mobility and materiality. To

achieve this aim, we explore the relationship between (assisted) self-repair in a Bike Kitchen setting, cycling, and other practices mediated by cycles. Theoretically we draw on Social Practice Theory and empirically ground our study in our own experiences in organizing and operating a local Bike Kitchen in Uppsala (Sweden), supported by observations and interviews. We suggest that Bike Kitchens are agents in and for urban mobility transformation, as they engender benign practices and transpose their constituting elements to other practices. Two questions guide our study:

- How can we conceive of the cycling-repair relationship as a social practice relation?
- How might a practice perspective on cycling and repair in Bike Kitchens contribute to transformational urban change?

Our contribution with this paper is threefold. Firstly, we add weight to existing literature on social (community) initiatives as important change agents in urban transformations. Bike Kitchens form a disparate cluster of change-oriented initiatives with various change ambitions, in different community contexts. We acknowledge the particularity of the case and contribute with research on a specific Bike Kitchen arrangement in a Swedish University context that explicates the flexibility of assisted cycle self-repair arrangements that nevertheless might find resonance with, and prompt inspiration in, other contexts. Secondly, we develop a conceptual notion of the cycling-repair relationship to identify practically relevant leverage points to support cycling and other convivial, benign practices. Thirdly, we outline how this relationship is relevant for practical means to allow actor groups to diversify perspectives on urban mobility.

We first outlining how practice theories inform an understanding of repair in relation to cycling. We then present a conceptual model of the cycling-repair-relationship. Thereafter, we elaborate on the methods, the analytical procedure and material that guided the empirical part of our study. We continue by applying our conceptual model to a Bike Kitchen case in Uppsala. Our concluding discussion then revisits the research questions and suggests future research avenues.

Cycle repair as a social practice

Practice Theory allows the examination of the role of material entities and how they connect with, or are a part of, practices (Nicolini, 2012; Shove, 2016; Schatzki, 2001, 2019). Compared to other social theories, practice theories re-center the analytical focus, moving from the acting individual as 'agent' to the individual as a 'carrier' of practices. As a consequence, practice theories represent activities, such as cycling and cycle repair, in ways that allow for novel forms of interventions to spread and consolidate practices. For the Sociologist Elizabeth Shove and her colleagues (2012) the material world is an inherent part of practices, where for example, repair and cycling practices share the bike as a material element (Hargreaves, 2011; Hui, 2016). Shove et al. (2012) developed a pragmatic approach to better understand everyday practices and how they change. We adopt their understanding of practices for its emphasis on the emergence, change and material focus on practices. In doing so, we follow previous practice-oriented studies on cycling (e.g. Cass & Faulconbridge, 2016; Larsen, 2017b; Spotswood et al., 2015). Shove et al. (2012) suggest four leverage points to intervene in practices: (1) the constituting
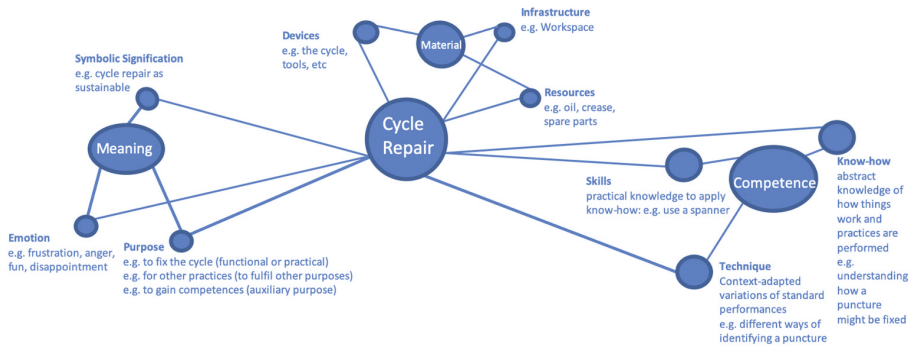
Figure 1. The cycle repair intra-practice relation exemplified by cycle self-repair.

elements that make up practices, (2) the ways in which practice relate to one-another, (3) people as practice carriers and (4) the social networks reproducing practices.

Following Shove et al. (2012) we can conceive of practices as aggregations of three elements: competence, material, and meaning. In contrast to Shove and colleagues (2012), we break each element down further into what we call 'dimensions' of practice elements in order to better distinguish between different modes of practice connections and interventions. Figure 1. presents the practice of cycle repair broken down into elements and dimensions. The cycle repair node at the center connects its three comprising elements (competence, material, and meaning); it acts as a 'hub' joining practice elements. Each element is in turn made up of dimensions, which we recognize as nodes within and between practices. Within a practice, each node is essential for establishing the connection between the central 'hub' and the three elements. More connections between dimension and elements, means more connections between elements and the practice 'hub', resulting in a more stable practice arrangement. Each dimension can furthermore act as a 'connecting link' to other practices outside repair, such as cycling. We return to this notion of inter-practice relations under the section *material relations in cycling and repair practices*. Next, we introduce intra-practice relations as connections between elements and dimensions.

We dissect competences into *know-how* (Löwenstein, 2017; Fuller, 2013), *skills* (Bäckström & Gustafsson, 2017; Dreyfus & Dreyfus, 1980; Ogbuanya & Chukwuedo, 2017), and *techniques* essential to practices (cf. Becker, 1978; Shove et al., 2012; Van Tuinen, 2017). Novice repair practitioners might not know how to perform repair, including identifying the cause of failure, knowing which tools are required and how to use them. Competence also requires knowledge of how a bike, or parts of it function. With *know-how* we capture the general understanding of a practice (cf. Schatzki, 2002; Löwenstein, 2017; Fuller, 2013). We see *skills* as the application of said know-how, such as being able to use a spanner, or adjust brakes with a barrel adjuster (Bäckström & Gustafsson, 2017; Ogbuanya & Chukwuedo, 2017). *Technique* in our understanding relates to different ways of conducting repair, under different conditions, using different materials and skills, such as patching a punctured inner tube with a repair patch, compared to a self-made patch from an old inner tube, compared to replacing the whole inner-tube

(Van Tuinen, 2017;. Know-how, skills and techniques do not develop linearly, but in an iterative process that is closely related to the meaning dimensions of affect (emotions and moods) as part of practice performances (cf. Fuller, 2013). Fuller, (2013) develops the argument that know-how represents a tacit form of knowledge that cannot be transmitted through (explicit) verbal or visual inscriptions (e.g. 'how-to' texts or videos), but depends on the experience of material engagement. Fuller posits that the *conditions* for know-how can be conveyed for the practitioner to unpack through the embodied experience of craft and repair work. Our conceptual understanding of knowledge in practices aligns with Fuller's (2013), but differs terminologically in that we adopt 'know-how' more literally as the explicit knowledge of knowing 'how-to', while *skills* capture the applied, embodied dimensions of developing tacit knowledge. By gaining experience through continued embodied material work, the practitioner can develop a level of virtuosity we capture through the competence dimension *technique* (Becker, 1978; Van Tuinen, 2017).

Materials are the physical elements of practices, where Shove (2016) describes three basic material-practice relations: 1) resources that are consumed, 2) devices that are interacted with, and 3) infrastructures that build a material background to enable practices but are seldomly consciously interacted with. In the case of Bike Kitchens, these can be e.g. oil (1), tools (2), and the workshop space (3).

The third practice element, *meaning*, broadly conceived denotes 'the social and symbolic significance of participation at any one moment' (Shove et al., 2012, p. 24), or 'symbolic meaning, ideas and aspirations' (Reckwitz, 2002 see Shove et al., 2012, p. 28). Yet, there is no clear consensus among practice theorist on how to conceptualize 'meaning' in practices (Shove et al., 2012). To guide our analysis of meaning, we draw on Schatzki (1996, 2019) and conceive of meaning as a three-split practice entity to: give purpose to practices, account for an emotional and affective frame of and for practices, and assign significance to practices outside their immediate purpose.

Symbolic signification, helps to orient a practice in arrangements of practices that make up social life and share a similar meaning. For instance, cycle self-repair might carry the symbolic significance of sustainability or thrift (Bradley, 2018) and can connect to other practices with a shared meaning (Hui, 2016; Reckwitz, 2016). Cycling could equally carry meanings of sustainability and economic viability (Fishman et al., 2015).

Practices carry *purpose* (Nicolini, 2012). There are conscious or subconscious reasons for practices. When a person enters a Bike Kitchen with a non-functioning bike, it is probably to repair the bike. Yet a practice can have multiple purposes; in addition to fixing one's own bike, a visit to the Bike Kitchen may be to develop repair know-how and skills. Practices can be broken down into smaller, individual sequences of actions that connect through their purpose (to meet an end). Practices often involve a combination of subordinated and hierarchically organized steps (Schatzki, 2019). The practice of repairing a flat tire, requires the removal of the wheel, which in turn involves loosening bolts, unhooking brake levers, etc. Schatzki (2002) terms the relations between such actions part of a 'teleoaffective structure'. Bike self-repair can equally be part of different hierarchies, such as gaining repair competences (learning), or socialisation (cf. Rigal, 2023).
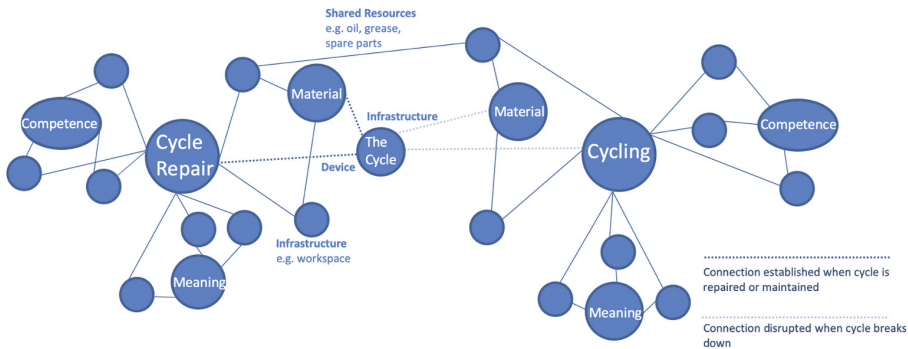
Figure 2. Inter-practice relations between cycle repair and cycling.

Emotions and moods are the last dimension of the 'meaning' element (cf. Schatzki, 2001). Meanings are delicate, change quickly and are coupled with emotions (Shove et al., 2012, p. 49; Fuller, 2013). Timid first-time Bike Kitchen visitors might feel empowered after a successful repair session, which may affect how they perceive the meaning of future bike self-repair (Shove et al., 2012). Through successful enactment, repair can be decoded from something a person is uncomfortable with and recoded as an enjoyable alternative to repair services. Conversely, unsuccessful repair may lead to frustration and reduce the appeal of future repair engagements.

Figure 1 visualizes a dendogram of repair, highlighting the multiple opportunities, or points of intervention each branch offers to strengthen or weaken other practices (cf. Shove et al., 2012). New practices can be created by developing new connections to already existing practice elements as visualised by the dendogram branches. Cycling, could be added to the dendogram as a further connection to 'Cycle Repair' as both convey 'sustainability' in practices; they are connected through their 'symbolic signification' (see Figure 2). In the following section, we further explore the repair-cycling-relationship and how it can be severed through processes of breakage and deterioration.

Material relations in cycling and repair practices

Even though cycling is a complex practice including pedaling, steering, balancing, navigating etc., the cyclist rarely consciously relates to the bicycle while cycling (Scheurenbrand et al., 2018). The cycle becomes an 'unproblematic means to an end, rather than an independent thing to which I [the person cycling] stand[s] in relation' (Cetina, 2001:178). As part of a habitualised performance, the cycle can slip out of awareness as cyclist and cycle merge in the practice (cf. Larsen, 2017a; Spotswood et al., 2015). Winner (2014) describes the subconscious material-practice-relation as similar to sleepwalking (see also Rosen, 2004). In these instances, the bike becomes 'infrastructure', which Shove (2019) describes as being necessary for a practice, but largely forms a material backdrop. In moments of malfunction or breakdown, the cycle slips back into awareness as an entity separate from practice and body (Cetina, 2001).

Relating to the bike as infrastructure implies little engagement with, or care for, the bike except when it is broken, or malfunctions.

We share the position that material semiotics are commensurate with theories of practice (Evans, 2020). Similar to practices, objects or devices are argued to have a function – a built-in purpose – which enables practices (Miettinen & Virkkunen, 2016). Breakdown or failure of the device (the bike) signifies a severed relation between purpose and practice, which can occur in different ways (Martinez and Laviolette, 2019). The malfunction of a cycle can be seen as a spectrum from slow and creeping deterioration to direct and abrupt breakage (de Chatillon M 2022b). Deterioration might not initially inhibit the function of an object, yet may eventually lead to its breakdown (de Chatillon M, 2022b; Godfrey et al. 2022; Graham and Thrift, 2007). Often an initial change in a bike's material capacity goes unnoticed by the cyclist, who automatically adapts to the deterioration. Over time brake pads wear down, to which the cyclist adapts by successively braking earlier in anticipation of a stop or change of direction (cf. Godfrey et al. 2022). The severity of degradation on cycling quality is often first perceived in direct comparison. Anyone who has experienced changing from a run-down bike to a new one has probably felt this difference in performance. Having other people ride your bike can also be used as an indicator to reveal unnoticed maintenance and repair issues (cf. Rea & Jacques, 1987).

Generally, processes that reinstate a certain quality of functioning, or impede degradation, fall under the umbrella of maintenance measures (Godfrey et al., 2022), such as straightening a slightly buckled wheel, lubricating the chain, pumping tires, etc. Over time, lack of maintenance materialises in a poorly functioning, unsafe bike (de Chatillon M, 2022b). Repair is a special craft-based practices, because it is reductive (Martin, 2016). Compared to creating a custom-designed cycle from scratch, repair re-creates a bike with fewer mechanical problems.

The bicycle as a technology is assigned symbolic meaning, such as sustainability (Batterbury & Dant, 2019). There appears to be something special about the bicycle that sets it apart from many other technologies. Ivan Illich (1972) described the bicycle as a convivial technology, meaning a technology that engenders autonomy in use, without creating further demand (see also Bradley, 2018). Whereas the car depends on the system of automobility, including roads, parking spaces, fuel stations, repair services (Urry, 2004), the cycle poses little of these demands. Bradley maintains that conviviality is also inherent in the bike as its workings are intelligible and can readily be changed and repaired (2018:1677f). Compared to other technologies with 'blackboxed' inner workings (cf. Latour, 1999; Fuller, 2013), many cycle functions can be observed and comprehended by close visual inspection.

For novice practitioners, the cycle's characteristics make it conducive to repair and maintenance (Batterbury & Dant, 2019); the threshold to understand how parts of the cycle function, or to gain know-how, is lower compared to other technologies. Nevertheless, we see repair and maintenance (especially when not routinised and habitually performed) to require a conscious and attentive form of engagement with technology in line with an understanding of epistemic practices. Following Karina Knorr Cetina (2001;1997), we conceive of repair and maintenance as 'non-standard forms of engagement' with the bicycle that provide opportunities to change how we understand the bicycle (its meaning) in conjunction with practices. We illustrate the relationship

between cycling, the cycle, repair and maintenance in Figure 2. One of the permanent linkages between repair and cycling, or cycling and maintenance, is created through shared resources. Resources such as oil, grease, or spare parts are essential for both repair and maintenance. They *can* also be part of cycling's material components, provided the bike and the practice of cycling carry a certain meaning, such as that of a sustainable, or flexible mode of mobility (not indicated in Figure 2.).

When the cycle breaks down, the cyclist becomes aware that the bike does not function as intended. An example might be a puncture discovered while departing to visit a friend. The cycle is no longer part of the practice arrangement; the connection is severed until the tire and/or tube are fixed. As part of the material elements, the cycle changes its infrastructural role and becomes the essential device for cycle repair. Without a broken bike no cycle repair; without a functioning bike, no cycling. Bringing cycling in relation to repair emphasises care in material relations and broadens conceptions of the bike as more than a utility vehicle (cf. Horton, 2006).

Case context

This study is based on material gathered from the Ultuna Cykelköket (Bike Kitchen Ultuna) located approximately 5 km from Uppsala's city center on the campus of the Swedish University of Agricultural Sciences (SLU). About two-thirds of Uppsala municipality's 240.000 inhabitants live in the inner-city area, where most services, employers, shops and the city's two Universities are located within a five-kilometre radius around the city centre (Statistic Sweden, 2023). 460 km of the 557 km of municipal cycleways are within the urban area, the majority of which physically separates motorised from non-motorised traffic (Uppsala Municipality, 2023). About a third of all inner-city trips are conducted by cycle. The high cycle mode share is often accredited to the high student population, moderately flat topography and compact urban layout. The municipality describes Uppsala as 'a cycling-friendly municipality' (Uppsala Municipality, 2013a, p. 3) with a 'well-developed cycling path network, especially in the urban area' (2013b, p. 3) and a 'deep-rooted cycling culture' (Uppsala Municipality, 2016, p. 8). The municipality, a local cycling organisation (Uppsala Cykelförening) and the local branch of Sweden's largest cycling advocacy Cykelfrämjandet offer cycling-supporting interventions and projects. To our knowledge, Ultuna Bike Kitchen is currently the only weekly open cycle repair workshop.

The idea to establish the Bike Kitchen emerged from the first author observing many bicycles in Uppsala in need of maintenance prompted by previous experience in Bike Kitchen volunteering. Established in 2019, the Bike Kitchen might be an unusual case in that the first author is the only permanent volunteer, Bike Kitchen founder and organiser of weekly open repair workshops. While volunteer engagement is practiced, encouraged and highly appreciated, it is not expected or planned for in the Bike Kitchen's regular operation. The operational and organisational model emerged over time as the least time consuming and most resilient in the particular context. The ambition for the Bike Kitchen was (and is not) to scale in size, or to offer a wider range of services, but to enable assisted repair and maintenance opportunities on a local scale. The Bike Kitchen

received seed funding from SLU for purchasing repair equipment, while the locale is provided by the state-owned property company Akademiska Hus for a nominal rent that is in turn covered by the Department of Urban and Rural Development at SLU. The Bike Kitchen receives bicycle donations from local housing companies and the campus facility management as well as material donations from Bike Kitchen visitors.

Material and methods

A combination of approaches is recommended to analyse practices (Hitchings, 2012, Nicolini, 2012). Hence, we assembled our empirical material through different methods; observations, interactions and interviews around the Ultuna Cykelköket. The first authors active participation, Bike Kitchen organisation and operation provide an (auto)ethnographic context to observe and be part of the workshop practice under investigation in this article (Hargreaves, 2011). Additional material was gathered through interviews. Together with a volunteer, the main author invited people through a local sustainability network to participate in repair crash courses with the aim of developing repair skills to become prospective Bike Kitchen volunteers. We hosted two workshops, each lasting 4–5 hours. We documented the workshop practices through photographs and interviews with workshop participants and conducted semi-structured interviews with nine respondents each lasting 30 to 90 min. All interviewees expressed interest, or attended, at least one of the crash courses. All interview respondents furthermore expressed interest in contributing to bike repair initiatives by volunteering and improving their repair skills. While some have extensive experience in organizing, running, or volunteering in bike repair spaces, others have visited Bike Kitchens before, but not previously assisted in bike repair. Photographs were taken during one of the crash courses and used as prompts during interviews (Törrönen, 2002). The photographs provided cues to speak about depicted practice performances, or to uncover meaning as part of practices (Törrönen, 2002). All except one interview were conducted in person, audio-recorded and later transcribed in full.

We oriented the interviews towards elements of practices (material, competences and meaning) of bike self-repair in Bike Kitchens. We sought to capture competences (know-how, skills and techniques) by asking participants to describe how they would perform a certain repair procedure, noting the general level of nuance they expressed when talking about repair practices. We also observed engagement during workshop participation. Paying attention to sequencing of actions allowed us to distinguish between different activities that make up a practice, such as the distinction between identifying/diagnosing a problem and the actual process of repair. We further sought to tease out meaning as an overarching element between material and practice, by questioning individuals' reasons (purpose) for their interest in Bike Kitchen activities, beyond the utility function of fixing one's own bike. Expressions of motions and affections when talking about practices further provided cues for auxiliary meaning categories. We also posed questions relating to the material elements of Bike Kitchens and the bicycle, where interviewees' comments revealed further material semiotic characteristics.

While the results are based on workshops and interviews, our own experience in establishing, organizing and running the campus Bike Kitchen inevitably affected the

analysis. As Nicolini (2012) notes, deep immergence is advantageous and provides a tacit background for first-hand experience. Our own experience in bike repair informed our methodological approach and facilitated the interpretation of observations and interview material. We use direct to interview participants' quotes and references to distinguish their voices from our overarching 'ethnographic' experience and other researchers' contributions.

We analysed interviews through a qualitative content analysis following an abductive approach (Bryman, 2016; Patton, 2002). Thematic abduction implied using practice elements as thematic guides to interpret the interview material, while at the same time allowing for new themes to emerge inductively (Kent, 2022). While our questions are oriented at the general level of practice relations, we cannot generalise to other Bike Kitchen contexts. Instead we strive for exemplifying practice-connections in its contextual subtleties (cf. Flyvberg, 2001).

In the following section, we discuss the empirical material in light of our conceptual understanding of practice relations and relevant literature.

Bike Kitchens and cycle repair

Bike kitchens as material containers

Interview participants recognized the advantage of centrally located Kitchens, with easy access by other transport. Acute repair presents a non-standard practice for most people, which makes ease of access to Bike Kitchens important to slot bike repair between sequences of other activities that make up everyday life (Shove et al., 2012). Urban centers are typically referenced as desired locations. Respondents also recognised the benefits of locating Bike Kitchens on, or around, university campuses, or close to student areas in the city. Referring to the Ultuna Bike Kitchen, interviewees identified that despite being located on a university campus, being removed from the city center is a barrier. While Bike Kitchens on campus could attract employees and students, ideally a Bike Kitchen close to the city center could draw in a more diverse group of people.

While accessibility and proximity are important, the actual physical space and material layout appears to be of less importance. A few respondents commented on the details of the material space, such as ease of access into the Bike Kitchen with a bike, sufficient room, adequate temperature, good lighting conditions, a concrete floor, and clear signage from outside (interviewee #7 and #5). Apart from basic design attributes, it appears most important to *have* a locale for bike repair. In this view, the Bike Kitchen becomes an infrastructural element that serves as a background for repair practices (cf. Shove, 2016).

Devices (tools) and resources (e.g. oil, grease and spare parts) are brought to the fore in the interviews, deemed more important than the Bike Kitchen setup. Gieryn (2002:38) notes, reflecting on Giddens (1994), that: 'At the extreme, the physical side of built places becomes almost irrelevant for social practices'. Applied to the Bike Kitchen the material shell is less important than the material it contains to support practices. This is certainly the case for the Ultuna Bike Kitchen, which has changed locations in response to the availability of locales. Participants had few expectations beyond the basic material components housed in a locale as outlined above. This provides flexibility regarding

the physical environments in which Bike Kitchen practices can take place. In fact, the tools and workshop devices are not tied to a building, but can be moved around as exemplified at Ultuna. When the weather conditions are suitable, the repair practices tend to flow out of the workshop as people set up their workstations outside. It is hence the material (devices and resources) more than the physical space (infrastructure) that constitute the Bike Kitchen.

A material aspect considered central when setting up the Ultuna Bike Kitchen, but that appears less important to interview participants are spare parts. While second hand material can work in certain cases, or be used for 'quick fixes', new materials tend to fix problems more sustainably (Hielscher & Jaeger-Erben, 2021). In our experience, the most common repair queries require resources that are being 'consumed' (puncture patching kits, inner tubes, brake pads, chains, etc.). Similarly, maintenance queries rarely require spare parts. The absence of interviewees mentioning the availability of spare parts, whether salvaged from old cycles, or new, is in our experience not reflected in the regular operation of a Bike Kitchen. Wheels, derailleurs, hubs and headtubes in different material conditions can be important for reference, or comparison, throughout repair and maintenance (Rigal, 2023; cf.; Shove et al., 2012). Dissecting an old wheel hub to reveal cup and cone bearings, alone or as part of transmitting explicit knowledge by other Bike Kitchen visitors, can help in gaining the competence to know-how the system works, how it can be manipulated, and how manipulation affects cycling.

Bike kitchens as social spaces of meaning

In practice theory, the body can be considered part of the material world (e.g. Schatzki, 2019). As with all social practices, being in the company of others is an essential 'material' prerequisite for Bike Kitchens (Batterbury & Manga, 2022; Batterbury & Vandermeersch, 2016; Bradley, 2018). A person can physically engage in someone else's repair, give advice, hand tools, etc., convey explicit repair knowledge (know-how) that conditions the development of skills (cf. Fuller, 2013) and technique (Becker, 1978; Van Tuinen, 2017). Interaction through practices implies connecting different meanings and competences. The interviewees described how the Bike Kitchen co-constitutes practitioners in different roles (Watson & Shove, 2022, p. 12; Alkemeyer & Buschmann, 2016). Learning throughout practices enables practitioners, and leads to diverse subject positions (Alkemeyer & Buschmann, 2016). Individuals assume different roles that express various meanings associated with practices. These roles in turn affect the meaning of a Bike Kitchen (Watson & Shove, 2022). For example, people become mechanics, but they also become teachers and apprentices.

An emotional dimension is closely connected to Bike Kitchen practices. Predominantly, events occurring in the Bike Kitchen are associated with positive emotions such as 'fun':

> '. . .probably one of the more important ones [aspects] that it's actually fun to actually be there [. . .] it's a friendly atmosphere to actually hang out. [. . .] otherwise why do it, you know?'. (Interviewee #4)

The term 'Bike Kitchen' alone serves as a semiotic vehicle to convey the social aspects inherent in the concept as one interview participant remarked:

> 'The kitchen part of it, the Bike Kitchen, I think, was ... to reflect this idea of building a community together. It's what brings you together. There's food that you can have, tea and coffee and biscuits there as well. And also, people can have [...] like a space to chat and get to know each other. So, it's supposed to be a community space as well as a skills workplace'. (interviewee #6)

The quote above underscores how the presence of materials and people affects the meaning of Bike Kitchen practices. Bike Kitchen participation for some becomes important outside the utility purpose of repair (symbolic signification). A clear example for meaning linked to bike self-repair practices is volunteering. Significations such as sociality and the exchange of competences give meaning to voluntary involvement.

Bike kitchens and competences

Rereading excerpt of interviewee #6 above primes us for elements of competence co-inhabiting Bike Kitchens addressed in this section. In addition to a material barrier to repair, there is a knowledge barrier that Bike Kitchens can help to overcome (Interviewee #9). One of the respondents exemplifies this as follows:

> 'And like the way that I understood it is that there's the materials and there's some people who know something and they try to transfer that knowledge to people who don't know that something, kind of'. (Interviewee #3)

Knowledge-transfer is a fundamental purpose of interactions in Bike Kitchens; some people are unsure of how to fix their own bike, but want to learn it, while others are willing to share their competence, or figure things out together. Hence, the existence of social initiatives depends on the reciprocity between practice carriers (Shove, 2012). For example, volunteer engagement is dependent on the 'willingness to exchanging very useful skills between you, and to people who ... , to anyone who wants to learn them, for free'. (Interviewee #6). What interviewee #6 describes as 'willingness', we interpret as the symbolic signification of Bike Kitchen practices beyond the utility purpose of fixing one's own cycle. The Bike Kitchen and the practices it enables signify what one respondent refers to as a 'circular' or more 'sustainable' way of living with less material resources (#2). Furthermore, cycle self-repair reflects the general meaning of self-repair as practices that increase autonomy in material relations. Circularity, sustainability and autonomy are examples of meanings beyond the immediate repair purpose that came through in the interviews. Others meanings are of course possible (de Chatillon M, 2022a). Reasons for frequenting Bike Kitchens beyond immediate repair do not have to be singular, but can connect to different meanings and be part of different practices (Hui, 2016; Mock, 2023). An interviewee with extensive volunteer experience describes the desire to convey knowledge as a driver for her engagement:

Figure 3. Volunteer (middle) explaining how to break and reconnect a bicycle chain with a chain breaker tool.

'. . . I want to show them. I want to transfer that knowledge, because I had to work to get it, you know, like maybe I can lessen the work for someone else because It's always helpful to be able to do these small things [adjusting chain tension] on your own'. (#3)

Learning and teaching are entwined in Bike Kitchen interactions. A person might be explaining how to remove a bicycle chain, and in the next instance learns how to remove a bottom bracket herself. Figure 3 shows the interaction between a workshop participant (middle) explaining to two other participants how to take a bicycle chain apart and reconnect chain links using a chain breaker tool. When shown the picture during the interview, the person explaining (middle) reflected that it captured her preferred way of teaching and exemplifies a combination of verbal and visual elaborations while providing continuous feedback on performances (cf. Fuller, 2013):

Interviewer: "You said that you really liked this picture".

Interviewee #5: "Yes. And it was heartwarming because it's two people learning the same skill together from someone who is not just doing it for them, but letting them do it while explaining what they have to do. I [. . .] really like the idea, like when you sit down and two people would need to learn how to do punctures. [. . .]. And that creates a bond between them as well. So they can go, you just go to each other for help [. . .]. I think it's nice because it means it's not just me acting, there are some of us who interact with each other".

Teaching someone is not only seen as purposeful in light of repair, but is seen as desirable and bringing about positive emotions. One participant for instance describes the process of teaching others as "gratifying":

'I also think that I learn more by teaching other people than just doing it, because when I just do it, then I kind of forget. But if [. . .] I can actually teach somebody else how to do it, then I know that I actually can do it. And so I think it's very gratifying [. . .] to teach others and to

show them that they can do it on their own. And then when they can, you know, the next time they show up and then, just do it and it's great' (#9).

The quote furthermore underlines the abstraction of teaching and learning; discussing cycle repair becomes a reflection on the generalized practice of teaching. Furthermore, *cycle* repair competences can become linked to repair practices in *general*; in addition to the cycle, other devices can become considered repairable (cf. Shove et al., 2012).

Bike Kitchen visitors are in a constant process of receiving, translating and mediating skills, know-how and technique; a process that dislodges the practice-specific competences of cycle repair and links them to other practices. The coding of knowledge is not only important for the mobility and circulation of cycle-repair elements, but for many competences (Fuller, 2013; Shove et al., 2012, p. 43). Participants compared joint learning (in the Bike Kitchen) to online self-education, or video tutorials on YouTube and Reddit (#2, #4 and #9). Tutorials can be helpful to know how to conduct repair by making competences mobile (Shove et al., 2012, p. 96; cf. Fuller, 2013). However, it can be difficult to apply competences and evaluate whether certain steps are performed in the 'right' way. In the Bike Kitchen other people can monitor the performance of a practice (cf. Shove et al., 2012, p. 75). Other workshop visitors are essential to decode knowledge and apply it to the practice at hand; they can help to unpack know-how, but also assist novices in skill development, or present different techniques for different scenarios. For example, to know how it feels when a bolt is 'tight enough' (skill), or that in absence of a bucket of water, you can find punctures in your inner tube by carefully listening to where air escapes, or feeling the air stream on your skin (technique). Where tutorials unilaterally provide the competence to 'know what you are doing' (Interviewee #9), a benefit to Bike Kitchens lies in the interaction between people to solve repair queries together and mediate from knowing what to do, to knowing how to do it and how it looks, feels and sounds when you are doing something right (cf. Fuller, 2013).

For example, learning can lead to the competence of knowing how to repair individual parts of a bike, through prolonged interactions the process of learning extends to developing repair skills and different techniques for repairing other parts of a bike.

Cycles' properties in relation to repair practices

Repair represents a different way of relating to the cycle potentially reframing its meaning and that of surrounding practices, such as cycling, or repair in general. In repair, the cycle becomes the focus of a practice – an 'object of enquiry'– through which new ways of acting can be observed (Miettinen and Virkkunen, 2016:438). Participant #7 explained that the bike is 'more than the sum of its parts'. In repair practices, the 'closed box' of the cycle is opened, when it becomes a system of levers, bearings, cables, bolts and screws (cf. Knorr Cetina, 2001:181; Latour, 1999).

> "And I guess when you learn that they [cycles] work and I think that, it's really cool to find out how something works by just logically thinking about it and seeing, 'okay, well this connects to this, so that means that actually something must be wrong with that, because of that' [. . .]. But just then you can, you know, look at any problem and not feel completely stuck, but at least give more of a diagnosis when it's broken". (#9)

Beyond the cycle, interviewee #9 describes how repair becomes about understanding the mechanical logic of how things work in general. The interviewee outlines the competence to 'know how things work' and relates it to understanding why things do not work; why they need repairing. An assessment of what is wrong prefigures practices of active manipulation and positions diagnosing in the sequence of repair. The centrality of finding out what is wrong has previously been described as the ' . . . kernel of a bike mechanics craft [. . .]' (Martin 2016, p. 73). Diagnosis can be applied to 'any problem' as the interviewee points out and highlights what has been described as the 'practice-generating' character of epistemic objects (Knorr Cetina, 2001: 183).

The reflections in this section highlight DIY cycle repair as a rewarding set of practices that depend on the cycle's characteristics as a thing that 'just makes sense' (#9) and is 'easy to fix' (#3). Minimal competence is required to start bike repair, the learning curve is steep and results can be achieved quickly (Bradley 2018). The cycle's comprehensible mechanical function makes it a rewarding repair entity as the following quote illustrates:

> 'The first time I brought my project back. It was very old. Mm-Hmm. [. . .]And I feel, I did feel like, hopeless. It was very bad. And. But you told me it maybe needed just air. And I pumped the tires. Yes, it works. And some other small stuff just brake adjustments and gears, and all was not so hard as I expected. Yes. And this made me so happy. So I could ride the bike'. (#2)

Despite the relative 'ease of repair' interviewees generally report a difference in the level of care different bikes receive. More specialised cycles are often entities of great affection in contrast to the 'everyday bike', which as long as it performs, tends to go unmaintained apart from measures that are very quick and have an immediate effect on performance, such as pumping tires and lubricating chains (cf. de Chatillon M, 2022a). Everyday urban cycles generally tend to be older and often second-hand, as to be unobtrusive and less prone to theft (cf. Larsen, 2017b; Scheurenbrand et al., 2018). The overall tendency of limited bike maintenance underlines its status as a mundane object that performs in the background even for our interviewees interested in bike self-repair (Knorr Cetina, 2001; Shove & Trentmann, 2019). Cycle repair can change the meaning of the cycle. For some people, this makes for continued and diversified engagement, for others, once the purpose of repairing is achieved, it becomes almost invisible until new problems occur (Rigal, 2023).

Concluding discussion

In this section we return to our initial research questions in an attempt to translate our findings into implications for deliberate change-oriented interventions.

How can we conceive of the cycling-repair relationship as a social practice relation?

Relations between practices provide leverage to induce changes in practices (Hui, 2016; Shove et al., 2012). This section details the complexity of practice relations in the Bike Kitchen and suggests *how* Bike Kitchens enable assisted cycle self-repair and mainte-nance that in turn contribute to other meaningful practices. Bike Kitchens can draw
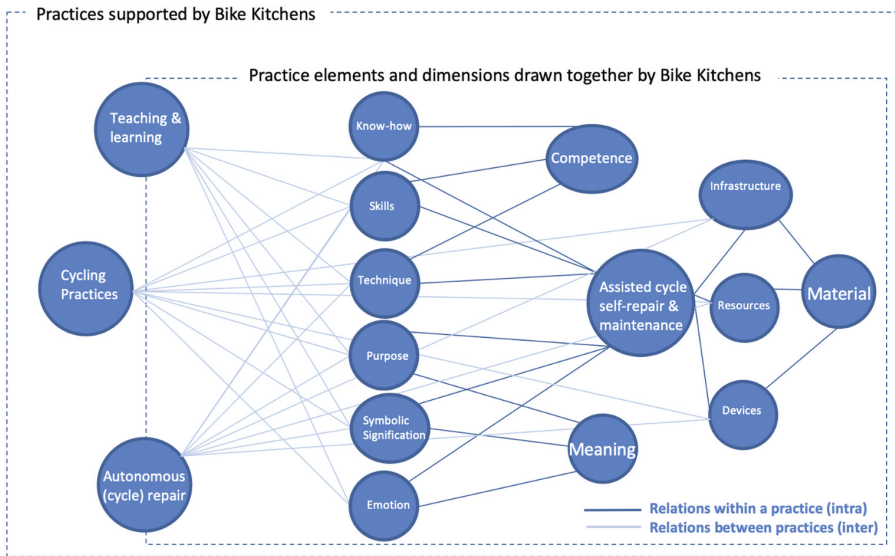
Figure 4. Practice relations exemplified by assisted self-repair practice in Bike Kitchens. Inter-practice connections are depicted in light blue, intra-practice relations in dark blue.

together disparate practices, such as cycle repair, socialization, teaching and learning. They do so through inter-relations between multiple dimensions which underlie practice elements. Our study reveals the dominant interrelations between the meaning dimensions and competences of assisted cycle self-repair, maintenance and other practice. Figure 4 illustrates the interlacing of assisted cycle self-repair and maintenance with other practices. Repair and maintenance stabilise cycling practices. Variations in practice elements are introduced through assisted self-repair as a visceral, bodily, socially and materially interactive experience. Connections occur dominantly through meaning and competence dimensions. Meaning and competence networks are further strengthened by the Bike Kitchen's and cycles' semiotic, or symbolic signification. Cycles' material characteristics as a comprehensible technology and the Bike Kitchen as social space of and for competences strengthen the meaning-competence-nexus further. While material elements are essential to Bike Kitchen practices (e.g. people, tools and spare parts) they form fewer connections. Material prerequisites brought together in a Bike Kitchen support several other practices. Importantly, the supported practices transcend workshop spaces and temporally bound instances of assisted self-repair performances. Conceiving the nuance of practices allows for a different understanding of how Bike Kitchens stabilise the practice of cycling while enabling changes in other meaningful practices.

How can a practice perspective on cycling and repair in bike kitchens contribute to transformational urban change?

Bike Kitchens and the practices they engender are semiotically close enough to cycling to maintain a meaningful connection to transport and mobility. Yet, Kitchen practices are

also meaningful in light of other practices that are purposeful, symbolic and emotional. We argue that particularly the meaning dimensions can act as spawning points for reconceiving urban life as more convivial, sufficiency-oriented and sociable, while not foreclosing other urban imaginaries. Bike Kitchens' multiple significations make them valuable additions to urban systems. Representing cycling as socio-material care, sociality and learning as well as the cycle as an epistemic object makes both amendable to various policies, plans and strategies beyond mobility. Previous research established that Bike Kitchens are spaces for experimentation with culture and education, production and consumption, resource governance, science and technology and alternative conceptions of work (e.g. Fitzpatrick et al., 2022). Bike Kitchens build on sufficiency in material relations and lifestyles in general. Instead of generating excessive waste, materials can be recycled and repurposed. Instead of relying on purchased repair services, people learn to re-engage with technologies' inner workings. Tools, spaces and competences become commons. Work in terms of volunteering is not a service or labor, but is exchanged for free as a redistributive and reproductive activity. These characteristics, make Bike Kitchens flexible instruments that can be integrated into a range of policies and grass-roots initiatives outside the realm of transport and mobility. Adding to their transformative character, Bike Kitchens don't directly critique the automotive system and thereby do not inadvertently reinforce dominant mobility discourses, but showcase the benefits of alternatives (Caimotto & Caimotto, 2020).

Based on our research we can add that Bike Kitchens might be even more sufficient in their requirements than previously outlined. Bike Kitchens do not have to rely on expensive locales, but might be organized as pop-up events, where for example volunteers collectively provide tools. Kitchens' organisation and operation *can* exclusively rely on volunteer support, or cooperate with various other actor groups. For example, can public, often municipal, actors contribute with providing locales. Housing associations can contribute by providing abandoned bicycles. These kinds of collaborations can stabilise social initiatives, but they can also lead to dependencies and undermine the multiple co-benefits of Bike Kitchens, for example, when they come under pressure to professionalise (Henriksson & Scalzotto, 2023).

Flexibility and multiple policy-relevant benefits make Bike Kitchens desirable candidates for collaborations with, or support through, public or private actor groups. Bike Kitchens might risk becoming tokenized to portray cycle-support and urban placemaking as part of the 'standard' array of policy instruments (Sheller, 2020). Instead of challenging the urban system, Bike Kitchen may end up feeding into it. Bike Kitchens are not shielded from assimilation into mainstream policy practices. Reciprocity and mutuality in assisted bike self-repair fit the prevailing rational of individual responsibilities in neoliberal governmentality (cf. Spinney, 2020, 2022). We content that the Janus-faced character of Bike Kitchens is an inherent advantage that positions them as useful 'narrative' vehicles. Because they can be adapted to various socio-political contexts and supported in various ways, Bike Kitchens are open for collaborations with other actors and enable open-ended, non-prescriptive, inclusive and pluriversal urban imaginaries.

Despite our praise, we must emphasise that Bike Kitchens are no panacea for vélomobility. They might spawn new ways of thinking about, and enacting, socio-material relations, but are unlikely to spread these new meanings on their own. Even if

more people embraced cycle maintenance and repair practices, their role in transforming mobility might be questioned. New ways of seeing and thinking need nurturing to become viable alternatives as to eventually find reflection in policy rationalities (Te Brömmelstroet et al., 2022).

Leyendecker and Cox (2022) remind us that"[c]hange does not happen evenly or consistently, and individual people, with their own histories and involvements, continue to be important as both motors for, and brakes upon change" (Leyendecker & Cox, 2022, p. 7). The Bike Kitchen is an example of a social setting where active individuals might instigate such change.

Bike Kitchen are in a position perhaps not to challenge, but to question, socio-material relations. Our Bike Kitchen experiences point towards the embodied dimensions of benign practices, such as reciprocity, conviviality, sufficiency and care. What Leyendecker and Cox (2022, p. 7) observe in cycling activism, we observe in Bike Kitchens as (advocacy) interventions: they are heterogenous and reveal 'ontological concerns: the kind of people we desire to be and the kinds of realities we inhabit. [. . .]. So, an important part of that discussion concerns the social relations and relationships that we wish to foster'. Assisted self-repair and maintenance in Bike Kitchens as well as other cycling advocacy and activist initiatives convey notions of self-efficacy, autonomy and resilience as part of alternative forms of governing practices (Bradley, 2018; Lange & Bürkner, 2018; Quick and Feldman (2014). They offer insights into alternative mobility and urban narratives that deserve more scholarly attention, the Bike Kitchen suggests entry points to reconceive and rethink mobility, with implications on how we act not only *on* mobility, but *for* fundamental mobility changes. Bike Kitchens might transcend growth paradigms and adverse mobility notions to provide 'deep leverage points' for system change (cf. Te Brömmelstroet et al., 2022).

The present case is but one example of in-depth investigations of a Bike Kitchen arrangement in a Swedish context (e.g. Bradley, 2018; José Zapata et al., 2020). Previous research in Swedish contexts has already investigated Bike Kitchens as part of the urban sharing infrastructure (Hult & Bradley, 2017), citizen-driven waste-prevention initiatives (José Zapata Campos & Zapata, 2017), prosumption, consumption governance (Lehner, 2019), circular economies (Bradley & Persson, 2022), and more specifically bike-sharing initiatives in circular futures (Henriksson & Scalzotto, 2023). Like the present article, most have done so with reference to single cases. In light of the growing body of 'Bike Kitchen research' future studies might utilise comparative approaches to interrogate commonalities and differences between Bike Kitchens on national scales and beyond. Conceptually, future research might explore the intersections between cycling and other practices through shared elements (e.g. Mock, 2023) to better understand in which ways desired practices may be supported and while others reduced. We further encourage research to engage with the embodied and experiential characteristics of cycling in conjunction with nurturing alternative cycling narratives. Where the position developed here supplements narratives of sociomaterial care, future research might explore community street interventions in light of a commoning mobility narrative (Nikolaeva et al., 2019). In relation to mobility as unnecessity (Te Brömmelstroet et al., 2022), research might also position personal mobility as a privilege. For instance, through research together with people

challenged to experience cycling on their own (Andrews et al., 2018; Clayton et al., 2017), or by exploring social cycling initiatives that assist in experiencing cycling mobility (Cotnam, 2020; Gray & Gow, 2020; McNiel & Westphal, 2020).

Disclosure statement

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Authors' contributions

Daniel Valentini developed the research design, collected the material, conducted the analysis and wrote the paper. Andrew Butler commented on and suggested revisions to the manuscript.

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This thesis explores how cycling is constructed through practices of representation, and how these constructions matter for how cycling is envisioned, practiced and governed. It argues that dominant representations subjugate imaginaries essential for mobility transformations. This is shown by analysing how cycling is represented in three contexts: research, planning, and a Bike Kitchen. Jointly, they illustrate why and how representations matter for cycling and cycling futures.

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