## Researching cycling innovations

*The contested nature of understanding and shaping smart cycling futures*

te Brömmelstroet, M.; Nikolaeva, A.; Nello Deakin, S.; van Waes, A. ; Farla, J.; Popkema, M.; van Wesemael, P.; Liu, G.; Raven, R.; de Vor, F.; Bruno, M.

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# Researching cycling innovations: The contested nature of understanding and shaping smart cycling futures

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ABSTRACT

With this commentary, we share our reflections at the end of a five-year interdisciplinary research project (from 2016 to 2020) on cycling innovations in living labs across the Netherlands. The commentary is the product of a collective writing effort of the researchers. It combines reflections on both the content of our research project (cycling through the lens of innovations) from various disciplinary perspectives – including socio-technical transitions, mobilities, urban design, transport planning and history – and reflections on the transdisciplinary approach (living labs) underpinning our research. We hope that our reflections can benefit other researchers concerned with similar topics and approaches.

Our research project, Smart Cycling Futures (SCF), began as a proposal within the Smart Urban Regions of the Future (SURF) program, funded by the Dutch Council for Academic Research (NWO). This call of €16.5 million was co-financed by the Dutch Ministries of Infrastructure & Environment and Internal Affairs. As one of the five winning consortia – the other consortia focused on self-driving cars, influencing travel behaviour, demand-oriented public transport, and small-scale experiments – our group of mobility-oriented researchers played an active role in shaping the evolving landscape of smart mobility innovation in the Netherlands.

With this commentary, we share our reflections at the end of a five-year interdisciplinary research project (from 2016 to 2020) on cycling innovations in living labs across the Netherlands. The commentary is the product of a collective writing effort of the researchers. It combines reflections on both the content of our research project (cycling through the lens of innovations) from various disciplinary perspectives – including socio-technical transitions, mobilities, urban design, transport planning and history – and reflections on the transdisciplinary approach (living labs) underpinning our research. We hope that our reflections can benefit other researchers concerned with similar topics and approaches.

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Our research originated from the growing consensus that cycling has a positive impact on social and ecological sustainability. In recent years, many cities and urban regions have articulated ambitious cycling policies to encourage growth in cycling rates. Likewise, academic attention for cycling by transport planners, geographers, and historians has boomed in recent years. While many studies have studied long-term effects of cycling policies, the social and geographical determinants of cycling, and the environmental impacts of cycling (Heinen et al., 2010; Pucher et al., 2010), the effect of smart innovations on the larger cycling system, urban resilience and liveability has yet to be studied systematically.

Our project explored how cycling innovations may help build the foundations for vital, more resilient and liveable urban regions. Cycling innovations promise to deliver substantial benefits to urban areas in terms of accessibility, social equality, health, liveability, and greenhouse gas emission reductions. However, a host of smart cycling innovations has not been fully realized because they are not yet embedded in existing urban environments, infrastructures and institutions. We lack an understanding of to

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what extent these innovations have either positive or negative social, economic, and environmental impacts.

Cycling can be conceptualized as a "socio-technical system in transition" (Rotmans et al., 2001; Geels, 2002; Shove, 2012; Gössling, 2013). Such a concept focuses on the transformative change in urban mobility structures by looking beyond the bicycle as a technological artefact and its supporting physical infrastructures. Instead, it highlights cycling practices in everyday life as embedded in spatial, historical, social, cultural, economic, and political structures. These socially embedded structures provide stability to cycling as a "system". At the same time, such structures may also impede efforts towards more radical change and substantial improvements to cycling practices. Much of the societal debate on mobility and, relatedly, the way that urban design is approached, remains car-centric by default, with cycling, walking and other ways of moving through space or dwelling being marginalised (see Prytherch, 2018; Verkade and Te Brömmelstroet, 2020). From innovation studies, we know that novelties paving the way towards alternative futures that depart from the current car-centric mobility regime are generally first introduced on a smaller scale as pilot projects in an experimental environment (Hoogma et al., 2002; Brown et al., 2003; Bulkeley et al., 2015). To engage with the process of transition through experimentation, our project emphasized the role of so-called urban 'living labs'. Through transdisciplinary collaboration in various urban living labs, we studied how these processes of innovation to the socio-technical system of cycling can be accelerated.

Given the call's requirements, we worked closely together with four Dutch cities and their corresponding regions. These cities included Amsterdam, Eindhoven, Utrecht, and Zwolle which also participated in co-funding the project.[1] Although this set of cities (and surrounding regions) differ considerably in terms of size, composition, location, and design, they share a common belief in the potential of cycling to deal with various contemporary urban challenges. Participating in the SCF project enabled these cities to obtain policy-relevant knowledge in relation to how smart technologies and changing mobility patterns may shape the future of cycling.

To this end, four living labs were co-created in these four Dutch cities, in which practitioners (i.e. local/regional authorities and innovators/entrepreneurs) and researchers engaged with each other over the entire duration of the project. This bottom-up approach resulted in a variety of living labs across the four cities (see Table 1). Living labs were loosely understood both as a form of collaboration, and as actionable research projects. The positioning of 'living labs' as a key concept forged a sense of shared ambition and approach across researchers with diverse disciplinary backgrounds, whilst also enabling collaboration between researchers, policy actors, business, entrepreneurs and civil society actors. For policy actors, on the other hand, the living lab concept generated expectations regarding 'useful cycling research with impact' that moved beyond conventional research-policy interfaces.

Monitoring and evaluating these living labs and the ways in which they unfolded generated valuable lessons about future cycling innovations, and on the potential and limitations of the living lab approach. In this commentary, we aim to share these lessons with the wider research community, based on a collective brainstorm session in which four distinct themes emerged. These four themes are used below to structure our commentary:

1. Challenges and tensions of a living lab approach in relation to academic research.
2. Questions about the position of existing cyclists in relation to cycling innovations
3. Realisation of the limited understanding of the specificness of cycling in transportation thinking
4. Awareness about the political nature of doing critical research on cycling innovations while also accelerating their introduction through living labs.

Reflection 1 focuses on the living lab process itself, while Reflections 2 and 3 discuss current approaches to cycling innovation; Reflection 4, finally brings the discussions on the process and the contents of living labs together. For the reader who may be interested in diving deeper in a particular subject we provide a full overview of publications that came out of the project thus far in the Appendix 1.

## Reflection 1: challenges of living labs

Why did we adopt a living lab approach in this research project about cycling innovations? We observed that experimentation has become a contemporary and diverse phenomenon in governing urban transformations, and that it is key to understanding, designing and navigating processes of urban innovation (Evans et al., 2016). Drawing on a long tradition of scholarly work on socio-technical experimentation (Sengers et al., 2019), we know that successful innovation depends to a large degree on the early involvement, enrolment and collaboration of a variety of stakeholders such as researchers, users, businesses and regulators. On first sight, this seems much harder than just introducing a new product or service. However, testing an innovation in a real-world living lab environment allows for learning by doing, fostering new partnerships and collaborations, testing and verifying assumptions across technical, economic, policy or cultural dimensions, generating a sense of collective direction and future possibilities, and as such generating and broadening the potential for innovations that are more socially robust and acceptable.

Nevertheless, the living lab approach also raised a number of challenges. Living lab experimentation is not only about learning about an innovation (such as the desirability and impact of cycling innovations), but also about understanding the processes of experimentation. How should living labs be set up, managed and improved to provide the conditions for joint learning and reflection? An important success factor of living labs is to align levels of knowledge and expectations about experimentation processes across organizations. In our project, instead of aligning this upfront we practiced learning by doing through a joint process of co-creation, in which throughout the first 18 months we collectively explored which questions, processes, mechanisms and resources were needed and available in each urban context.

We experienced that the resulting challenges can be overcome by making them explicit. For instance, we quickly learned that the phasing and development of a PhD research project is fundamentally different from the implementation process of a living lab, in which the dynamics of multiple actors and interests create high levels of uncertainty. Making this explicit led to an alignment of learning goals, expectations, activities and roles. In some cases, PhD research became more deeply linked to actual living lab projects, whereas in other cases PhD research acted as a sounding board for reflection on the basis of fundamental research. In Amsterdam, for example, the living lab aiming to accommodate and further encourage the growth in bike-train commuting took a long time to take shape, so it was not possible for the PhD student to wait for the "exchange bike" system to be launched.[2] Instead, he participated in the meetings leading up to the experiment, designed the questionnaire addressed to users of the system, and conducted a large-scale survey of people using the bike-train combination for commuting in the Netherlands.

This process of "learning by doing" raised questions about how to organize leadership and management of a living lab. In the start-up phase, our living labs were mainly platforms of interaction with (sometimes too) broad visions and varying expectations. All parties (academics, innovators, policy makers) were expected to be involved in the living lab based on their own motivation to learn, and had an equal weight in the decision-making

[1] More details available at: https://smartcyclingfutures.nl/.

[2] "The exchange bike concept is very simple: half of the participants live at least one and a half kilometers from the station and the other half work at least that distance. Someone who travels further to work by train or metro in the morning, parks the bicycle in a specially reserved part of the parking facility under Mahlerplein. Someone who arrives at Amsterdam Zuid Station and wants to continue by bike, can use the same bike and put it back after work. The exchange bike changes users again at the end of the day, when another participant takes the bike home. That means: more bike rides with fewer bikes."(translated from Dutch by the authors, Source: https://www.vervoerregio.nl/artikel/20191007-wisselfiets-oplossing-voor-overvolle-stallingen-meer).

**Table 1**
Overview of cycling innovation living labs.

| Living lab | Exchange bikes | Free-floating bike sharing | Researching bicycle highways | Monitoring cycling infrastructure | Cycling lessons |
|---|---|---|---|---|---|
| Location | Amsterdam | Utrecht | Eindhoven | Zwolle | Zwolle |
| Aim | Experiment with a new bike sharing model for train commuters | Test the potential of free-floating bike sharing for a period of two years | Empirical research into bicycle highways as a new form of bicycle infrastructure | Learning about processes of collaboration between different governmental stakeholders | Learning from cycling lessons in order to stimulate empowerment and healthy living of underprivileged groups |
| Actors | Municipality, regional transport authority, railway company, university, | Municipality, university, bike sharing company | Regional government, municipalities, university | Municipalities, province, university of applied sciences | Municipality, university of applied sciences, welfare organisation |

and development of the process. This is typical for a living lab approach, but also led to difficulties in arriving at more specific decisions about which cycling innovations to experiment with. When some of the living labs decided to appoint a dedicated local manager at a later stage, this led to immediate progress. Imposing such a management structure took the co-creation phase into a more traditional project form, but fast-tracked progress in terms of living lab implementation. The role of these managers was to navigate between the academic and practical sides of the living lab and to take responsibility for its progress by providing clarity, direction and action to the living labs. Additionally, they also provided the linkages with formal governance structures.

Having partners from different backgrounds, roles and disciplines also posed challenges of understanding each other's language and logic. Practitioners tended to struggle with learning from academics, as the latter were working on more fundamental questions that may be less relevant for the daily practice of local governments and vice versa. What limits the learning potential is that stakeholders are grounded in different contexts representing different professional 'worlds', with different languages and professional jargon (English vs Dutch; abstract vs practical), different incentive structures, different outputs (policy & concrete plans vs. scientific articles), and different timeframes (long vs short term). We believe that the continuous contact during living lab experimentation contributed to overcoming some of these differences and in any case to learning about them and building connections across these two worlds for future collaborations.

### Reflection 2: including existing cyclists

One central tenet in the living lab approach is a user-driven, citizen-centric approach to innovation (Bergvall-Kåreborn and Ståhlbröst, 2009). Envisioned users can be included in the design process through lobby groups, institutions or direct representation. Users can also be included in evaluating/improving the innovation on the ground. Our project mainly took this second route. Discussing the different cycling innovations, however, raised fundamental questions about *who the envisioned user should be*.

Current cycling policies, planning and innovations have a strong tendency to focus primarily on increasing the attractiveness of cycling for people who do *not* currently cycle (Bruno and Nikolaeva, 2020). Typically, policies and innovations that try to convince people to get out of their cars and on a bicycle come with the unstated premise that people who drive will change their behaviour when they see new infrastructure, new monetary incentives, or new studies on the health benefits of cycling.

While such policies may have an important role to play, in our living labs we became increasingly convinced that such a focus can constitute a distraction from paying attention to the critical role of people who *already* cycle in sustaining and promoting a transition towards a more sustainable mobility system. Building on previous Dutch research, we argue that a cycling culture is shaped and defined by existing cyclists, and that a transition to a sustainable transportation system starts with understanding, supporting, and investing in the practices of those people. As illustrated in our research (Nello-Deakin and Harms, 2019; Nello-Deakin and Nikolaeva, 2020), the existence of a critical mass of existing cyclists constitutes a form of "human infrastructure" which plays a critical role in sustaining and encouraging urban cycling for all. Developing policies that improve the experience of existing cyclists helps advance a mode shift through the process of social feedback (Macmillan and Woodcock, 2017; Skov-Petersen et al., 2017), but it also furthers the transition to sustainable mobility by investing in the people most likely to lead that transition. It works to ensure that people who currently cycle keep cycling in the future, or more specifically, after they go through important 'life events' (Delbosc and Nakanishi, 2017; Jones et al., 2014; Zhang and Van Acker, 2017).

In practice, this involves rethinking the working definition of mode substitution. When considering which car trips could be potentially substituted with bicycle trips, it is easy to forget about all the car trips that are already not occurring because of existing cycling trips. In this latter form of mode substitution, persons who never drive have substituted all their driving for cycling (Piatkowski et al., 2015). Current cost-benefit analyses for cycling in the Netherlands, however, only look at the benefits that would result in people moving from driving to cycling and do not consider the costs of people moving from cycling to driving. This is remarkable, as a 21 year longitudinal study of mode shift in the Netherlands found that people were nearly three times as likely to shift from riding a bicycle to another mode than they were to shift from another mode to riding a bicycle (Oakil et al., 2016).

Rather than focusing exclusively on people who drive and assuming that any cycling investment that might lead to a change in their behaviour would be equally appreciated by existing cyclists, an approach that focuses on existing cyclists takes seriously the needs of people who have already made the choice to travel sustainably by creating policies that support them directly (Bruno and Nikolaeva, 2020). In the Smart Cycling Futures project, this emphasis on existing cyclists was reflected in the living lab in Amsterdam, which sought to provide a better solution for bike parking in the vicinity of train stations primarily for the benefit of *existing* cyclists.

### Reflection 3: the conceptual curb

In Reflection 1, we discuss how living lab partners have to find a common language to understand each other's roles. During our active engagement with cycling innovations, however it became evident that the same was true for *the topic of cycling* itself.

Metaphorically speaking, we found that the cyclist travels along a boundary that is a ubiquitous feature of every street: the curb. The curb is the clear physical boundary that divides the sidewalk from the street; the people who walk from the people who drive. It represents an invisible boundary between the logic of *walking* and the logic of *driving* a car (Hamilton-Baillie, 2004). We see the bicycle as a boundary object through which logics on either side of the curb can be explored; in matters of design, this exploration is both literal and conceptual. In a literal sense, the curb separates the motorized from the human-powered, the people in enclosed vehicles from the people exposed to their environment, and the fast from the slow. Conceptually, we observe that the rules and behaviour that govern these realms are also different. Slower speeds and eye contact leave more time for negotiation; in the absence of lane markings and traffic signs, informal and subtle rules work to allow people to "dance" around each other on the sidewalk. In short, walking is about slow pace and negotiated relations with fellow pedestrians while driving is faster, more anonymous and guided by strict rules (Te Brömmelstroet et al., 2017).

Where does cycling fit in between these two realms? Sometimes the bike is admitted to the sidewalk, but more often, the cyclist has to

manoeuvre between the cars. Cycling occupies a variable position within these spaces, and the non-conforming behaviour of cyclists reveals the obduracy of the infrastructure that cyclists often operate within (Latham and Wood, 2015). Where dedicated cycling infrastructure is added to the street, we see an additional modal boundary within the streetscape, thus complicating matters of equity in road space distribution (Nello-Deakin, 2019). Transport planners and engineers may have clear ideas about how to guide cars through the city in a fast, safe, and smooth way, yet cyclists have their own way of relating to the environment and to fellow travelers, and the specifics of this experience has been hitherto largely neglected. In exploring the characteristics of the cyclist, Forsyth and Krizek (2010) ask, "Would urban design considerations and practices be different if the experience of bicycling was given a more central place?". Our research shows that the cyclists' perspective is gradually making its way into the publication of new bicycle infrastructure design manuals that guide the work of practitioners. For academics, there is an opportunity to "mount the curb" by incorporating the research and insights of urban designers in creating environments to enhance the richness of the cycling experience (Liu et al., 2018).

While we found that practitioners themselves are aware of the limitations of the '*traffic mode*' of thinking, their ability to design bicycle infrastructure as social spaces is limited by requirements of institutions and funding mechanisms that they operate in. Taking the bicycle highway for example, aspects such as speed, directness, and efficiency dominate even when designers are explicitly asked about how cycling infrastructure can enhance user experiences (Liu et al., 2019). This shows us that even in the case of dedicated cycling infrastructure with no requirement to accommodate cars, adherence to strict vehicular parameters is still reflected existing design practices. When considering smart innovations, we should keep in mind that cyclists, like pedestrians, are already capable of smartly negotiating among themselves and that technology should complement, and not detract, from our existing innate ability to interact with others.

### Reflection 4: the politics of cycling innovation

What exactly *are* smart cycling futures? What does it mean to make cycling "smarter", as promised by different cycling innovations? In our work, we analysed descriptions of smart cycling innovations in order to understand what kind of futures are lurking behind promises of making cycling faster, safer, easier and more fun (Nikolaeva et al., 2019; Nikolaeva and Nello-Deakin, 2019; van Waes et al., 2018; Van Waes et al., 2020a). We concluded that smart cycling futures are multiple and contested, and may potentially bring about radically different types of transformations of urban mobility. For instance, while some innovators see smart technology as a way to make mobility even more efficient and the bicycle as a perfect car of sorts (with cyclists being little more than non-car drivers), others call for displacing the dominant narrative of mobility that prioritizes efficiency and speed, and replacing it with an appreciation of the sensory and social dimensions of velomobility (Nikolaeva and Nello-Deakin, 2019; Popan, 2019). Our analyses of a spectrum of cycling innovations and possible "smart cycling futures" served as a mapping of the territory well beyond the focus of our own living labs. These analyses were a way of orienting ourselves in the world of cycling innovations and thinking about their consequences. In conversations related to our living labs in Utrecht and Amsterdam, in particular, we raised questions that followed from our analyses and related to issues such as the transformation of the culture of bike ownership, the way cycling data is treated, and our understanding of the motivations of cyclists. Thus, we drew attention to the politics of smart cycling futures, which open some opportunities but also foreclose others. As academics, we should keep giving attention to that political nature of smart cycling futures and our own role within these. Choices for implementing particular smart cycling innovations in the present inevitably leads us to transformation of cycling practices, subjectivities and meanings of cycling – and we call for more reflexivity on the consequences of those transformations.

We have developed a critical perspective on the necessity, jeopardy and perversity of smart cycling innovations (see Te Brömmelstroet, 2014), recognizing the importance of the convivial simplicity of the existing bicycle. Nevertheless, our consortium was also a vehicle that accelerated local niches of cycling innovations and gave them prominence, thereby contributing to a specific politics of how to deal with niches (Savini and Bertolini, 2019). We were forced to confront the possibility that we had contributed to the dominant view of the bicycle as just another mode in the fleet of smart mobility modes. Could such pragmatic research strategies partly foreclose a future where the humble bicycle acts as a true alternative to predominant discourses around "smart mobility" for our urban mobility futures?

One example of this tension between criticizing and supporting cycling innovations is in our living lab in Utrecht. After a long period of searching for relevant and desired cycling innovations, the city of Utrecht and the researchers chose to develop a living lab around dockless bike-sharing. The academic relevance of this was clear for our team: studying whether a new generation of bike-sharing systems can play a role in a mature cycling context. For the municipality, the main question was whether bike-sharing could help to combat the overabundance of parked bicycles in public spaces across the city. Collaborating on researching these questions with an innovator (Donkey Republic was chosen after a market consultation) allowed the team to research the potential of bike-sharing in a hands-on manner. As a part of this, we supported the innovator by introducing their product on the streets of a popular student city (and global poster child for cycling cities) and by improving the product, studying what works and what does not. However, it also allowed us to study a more critical question: how does commercial bikesharing affect the conviviality of the personal bicycle? What does it mean if people lose a direct sense of ownership of the vehicle that they use? And how might this influence how citizens relate to each other and their surroundings?[3]

There is no one-size-fits-all approach to engaging in transdisciplinary research on innovation in a way that strengthens its critical potential. Learning from our own path, we see that each collaboration requires designing one's own way of combining observation and intervention, giving over the lead to other societal parties and taking a clear stance on the importance of particular academic questions. One of the ways that the Smart Cycling Futures project attempted to amplify its contribution to making the politics of cycling innovation explicitly is through regular dissemination of results via events organised for a diverse knowledge community of practitioners in the sphere of mobility and cycling in the Netherlands (from relevant ministries and teams in municipalities to an array of private actors and independent consultants). Furthermore, continuous individual and collective reflection on the role of the researcher in the project as a facilitator and (explicitly or implicitly) an agenda-setter in transdisciplinary projects is key for leveraging the value of such projects both for academic research and for society.

## Living labs on cycling innovations: overall reflections

We have shared four reflections from our experiences in the Smart Cycling Futures research project. These reflections are based on the experiences and insights of the academic researchers in five years of living lab research around cycling innovations. With this commentary, we aim to provide guidance for ongoing and future research around cycling innovations. As we see it, a living lab approach is an important prerequisite for responsible innovation (Stilgoe et al., 2013), a way to improve the design of innovation and improve the sensitivity for potential perverse effects. Instead of launching a pilot, a living lab promises a shared, multidisciplinary learning process that profits innovators, policy makers, academics and the general population. An important prerequisite is this willingness for shared learning. As our reflections show, it is also crucial that all parties are willing to reflect on deeper, political aspects of what cycling innovations mean and how they should be approached.

[3] This study is currently near completion, please see www.smartcyclingfutures.nl for updates or contact Anna Nikolaeva.

Reflections 2 and 3 centred on the perspectives that are used to approach cycling innovations. Currently, innovations often assume that by improving cycling conditions, non-cyclists will switch to using the bicycle. In Reflection 2, we have argued that it is also important to also give more consideration to existing cyclists in designing and evaluating cycling innovations. In Reflection 3, we argue that cycling falls in between the car-based logic of the street and the pedestrian logic of the sidewalk. To develop cycling innovations that benefit cyclists, there is a need for a more specific cycling-oriented logic.

Reflections 1 and 4 focus on the living lab process itself. This is an increasingly popular way of doing research on innovations and we support the importance of this for the quality of innovations and the quality of academic research. In our experience, the living lab approach brought us numerous advantages. The living lab:

- facilitated reciprocal learning and collaborations between the policy makers, the innovators and researchers about cycling innovations.
- allowed all partners to anticipate unforeseen consequences, for example with regards to parking and data handling.
- allowed us to test, learn and fail.
- made the 'responsible' institution (province and/or municipality) aware of more dimensions than just time and budget restrictions of a project and as such contributed to 'better' decisions.

However, the living lab method also raises some fundamental questions about the political nature of the work that academics then find themselves in. For us, this represented a dilemma: either staying outside of the innovation process for the sake of objectiveness and academic legitimacy or take an active seat at the table and have a richer, action-oriented understanding of the research object. As we see it, the benefits of a living lab approach mean that adopting an active role is a risk worth taking, but it is vital for researchers to develop a responsible and reflective stance in the process. Researchers need to be aware that the choice to be part of a living lab is in itself a political action, and one that will make certain futures more possible than others.

## CRediT authorship contribution statement

Marco te Brömmelstroet, Anna Nikolaeva, Samuel Nello-Deakin, Arnoud van Waes, Jacco Farla, Marcus Popkema, Pieter van Wesemael, George Liu, Rob Raven, Friso de Vor: Conceptualization, Methodology, Writing- Reviewing and Editing.

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**Appendix 1. List and description of publications by researchers in the Smart Cycling Futures research project**

| 0g | Title | Year | Journal | Keywords | Main ideas |
|---|---|---|---|---|---|
| Van Waes, A., Nikolaeva, A. & Raven, R. | Challenges and dilemmas of strategic urban experimentation. An analysis of four cycling innovation living labs | (under review) | - | urban experimentation; living labs; strategic niche management; cycling innovation | Strategic urban experimentation in living labs helps to learn about cycling innovations although reflexivity about the role of researchers is necessary. |
| Van Waes, A., Farla J., & Raven, R. | Why do companies' institutional strategies differ across cities? A cross-case analysis of bike sharing in Shanghai & Amsterdam | 2020 | Environmental Innovation and Society Transitions | Institutional work; bike sharing; business strategy; micromobility | Bike sharing companies adapt their strategies to embed innovation to local spatial and institutional contexts |
| Bruno, M. | The Challenge of the Bicycle Street: Applying collaborative governance processes while protecting user centered innovations | 2020 | Transportation Research Interdisciplinay Perspectives | Governance; innovation; bicycle streets | Collaborative governance processes can lead to innovations developed to serve cyclists being repurposed to serve the interests of people who drive. |
| Bruno, M., & Nikolaeva, A. | Towards a maintenance-based approach to mode shift: Comparing two cases of Dutch cycling policy using social practice theory | 2020 | Journal of Transport Geography | Governance;policy; cycling rates | Focusing cycling policy on existing cyclists can be just as effective in increasing cycle rates as convincing people who drive to ride a bicycle |
| Nello-Deakin, S. | Environmental determinants of cycling: not seeing the forest for the trees? | 2020 | Journal of Transport Geography | Policy relevance; urban cycling; cycling planning; environmental determinants; traffic evaporation | At present, the difficulties faced by the vast majority of cities across the world in encouraging cycling are not derived from a lack of theoretical knowledge, but are fundamentally practical and political. |
| Nello-Deakin, S., & Nikolaeva, A. | The human infrastructure of a cycling city: Amsterdam through the eyes of international newcomers | 2020 | Urban Geography | Cycling; local mobility culture; Amsterdam; human infrastructure | The physical and social factors which encourage cycling are inextricably linked, and cannot be understood independently of each other |
| Liu, G., te Brömmelstroet, M., Krishnamurthy, S., & van Wesemael, P. | Practitioners' perspective on user experience and Design of Cycle Highways | 2019 | Transportation Research Interdisciplinary Perspectives | Cycle highway; user experience; bicycle Infrastructure; urban design; mobilities | Practitioners have clear infrastructural standards for cycle highways, but pay less attention to how the aesthetic and social experiences of cycling can be incorporated in the planning of cycling highways |
| Nello-Deakin, S. | Is there such a thing as a 'fair' distribution of road space? | 2019 | Journal of Urban Design | N/A | Although arguments in favour of a fairer distribution of road space based on the imbalance between modal split and road space distribution are intuitively appealing, they are also excessively simplistic |
| Nello-Deakin, S., & Harms, L. | Assessing the relationship between neighbourhood characteristics and cycling: Findings from Amsterdam | 2019 | Transportation Research Procedia | Cycling; bicycle-oriented development; built environment;urban fabric | Neighbourhood cycling rates in Amsterdam are significantly related to both built environment and socio-demographic variables, which mutually strengthen the effect of each other |
| Nikolaeva, A., & Nello-Deakin, S | Exploring velotopian urban imaginaries: Where Le Corbusier meets Constant? | 2019 | Mobilities | Velotopia; utopia; cycling innovations; mobility futures; urban imaginaries; Le Corbusier; Constant | While (technology-centered) velotopian urban imaginaries may on the surface advocate the same kind of change (cycling as dominant mode), they in fact may propel very different urban futures and we need to carefully think |

(continued on next page)

(*continued*)

| 0g | Title | Year | Journal | Keywords | Main ideas |
|---|---|---|---|---|---|
| | | | | | before investing in them. |
| Nikolaeva, A., te Brömmelstroet, M., Raven, R., & Ranson, J. | Smart cycling futures: Charting a new terrain and moving towards a research agenda | 2019 | Journal of Transport Geography | Smart mobility; Cycling; Cycling innovation; Mobility futures; Grounded theory | Smart innovations change the way cycling is practiced, made sense of and governed. The article examines the differences between the promises of the innovations and the tensions within and between futures that they promise. |
| Liu, G., Krishnamurthy S., & Van Wesemael, P. | Conceptualizing cycling experience in urban design research: a systematic literature review | 2018 | Applied Mobilities | Cycling; mobile experience; methodology; movement | The article reviews how different academic fields have studied cycling experiences. |
| te Brömmelstroet M., Nello-Deakin, S., Quillien, J. & Bhattacharya, I. | Towards a pattern language for cycling environments: merging variables and narratives | 2018 | Applied Mobilities | Bicycle-oriented development; urban cycling; mobility; urban fabric; narratives; pattern language | Developing a "pattern language" holds promise for a more holistic understanding of cycling environments, which could help bridge existing ontological and epistemological divisions within cycling research. |
| Popkema, M., Kampen, H. & De Vor, F. | Lessen uit een living lab: de ontwikkeling van de regionale fietsroute Dalfsen-Zwolle [Lessons from a living lab: The development of the Dalfsen-Zwolle regional bicycle route] | 2018 | Colloquium Vervoersplanogisch Speurwerk [Transportation Planning Research Colloquium] | N/A | A living lab approach can be a valuable way of learning about cycling projects for both academics and practitioners, but requires lots of time and energy investment in order to make it work. |
| van Waes, A., Farla, J., Frenken, K. De Jong, J., & Rob Raven | Business model innovation and socio-technical transitions. A new prospective framework with an application to bike sharing | 2018 | Journal of Cleaner Production | Business model; socio-technical transitions; bike sharing; technology assessment | New business models may have upscaling potential - and thereby contribute to transitions - but require embedding into local institutional contexts |
| Te Brömmelstroet, Nikolaeva A., Glaser, M., Skou Nicolaisen, M., & Chan, C. | Travelling together alone and alone together: mobility and potential exposure to diversity | 2017 | Applied Mobilities | Mobility; diversity; connectedness; spatial diversity; social diversity; well-being | Different transport modes provide different types of social interaction. Adding this perspective to the transport policy debate is an important and often ignored element of policy discussions on mobility interventions |

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