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From conventional to electrically-assisted cycling. A biographical approach to the adoption of the e-bike

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ABSTRACT

Sales of electrically-assisted bicycles (e-bikes) have been rising in many European countries. Due to their electrical assistance, e-bikes could increase the number of people cycling and the potential uses of cycling. Existing research has not investigated the links between conventional cycling and e-bike use at the individual level. Using qualitative, retrospective data, this paper aims to determine how e-bike use fits into an existing cycling trajectory over the life course. E-bike users in the Swiss city of Lausanne (N = 24) are interviewed to compare their cycling trajectories. They fall into two main trajectories: "restorative" and "resilient", which each represent different relationships to cycling and different reasons to adopt the e-bike over the life course. E-bikes might serve as both a way to restore an interrupted cycling practice, or to keep existing cyclists despite threats posed by changing personal and spatial contexts.

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biographical approach; cycling; cycling trajectory; e-bike

1. Introduction

Sales of electrically-assisted bicycles (hereafter: e-bikes) have been growing in the last ten years, with e-bikes representing more than a third of all bicycles sold in Switzerland in 2019 (Velosuisse [Swiss Bicycle Suppliers Association], 2020) and up to half in the Netherlands (RAI/BOVAG/GfK, 2019). E-bikes are a new form of bicycle combining muscular power with an electrical assistance which activates when pedaling. In European countries and Switzerland, two categories of e-bikes are mainly present, namely those limited to an assistance of 25 km/h, or "pedelecs", as well as faster "speed-pedelecs" with an assistance up to 45 km/h[1].

E-bikes are part of a larger trend of the rebirth of cycling in cities in the last decade (Buehler & Pucher, 2012). By reducing the amount of effort needed to operate a bicycle, they could broaden the appeal of cycling to a larger spectrum of users, notably older people or those with physical limitations (Rose, 2012; Jones, Chatterjee, et al., 2016). Moreover, e-bikes could facilitate cycling over longer distances and in hilly terrain (Lopez et al., 2017), as well as carrying heavier loads or children (Popovich et al., 2014). Due to their increased range, they could substitute short car trips, and conventional cycling trips alike. It has been argued that e-bikes are more sustainable if the mode of transport they replace is car use rather than conventional cycling (Rose, 2012).

Most existing research on e-bikes is cross-sectional and does not address the long-term relationship to cycling that e-bike users may already have. In this paper, we argue that a biographical view of e-bike users' past travel behavior is necessary to fully understand the e-bike's role in relation to cycling. To do so, we adapt the notion of a "cycling trajectory" (Chatterjee et al., 2012; H. Jones et al., 2015) to include both conventional cycling and e-bike use over the life course. We aim to answer the following question: *How does the e-bike fit into an individual's cycling trajectory?* Using qualitative, retrospective data from interviews with e-bike users (N = 24) from the city of Lausanne, Switzerland, we reconstruct and classify the cycling trajectories of e-bike users.

In the following sections, we start by introducing biographical approaches to cycling and presenting our theoretical framework, before reviewing the available literature on e-bike users (section 2). Later, we introduce our methodology and data (section 3). Our results present two main cycling trajectories, as well as relevant subcategories (section 4). We then discuss our findings and the role of the e-bike in these cycling trajectories, as well as implications for future research (section 5). Lastly, we draw some conclusions (section 6).

2. Theoretical framework

2.1. Biographical approaches to mobility

Biographical approaches to mobility originated as a way of overcoming the limits of cross-sectional data which consider mobility at a specific moment rather than its evolution over time (Lanzendorf, 2003). These approaches have their roots

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[1]Although further types of e-bikes also exist which do not require pedalling, notably in China (Weinert et al., 2007), they are very rare in Switzerland and are not taken into account here.

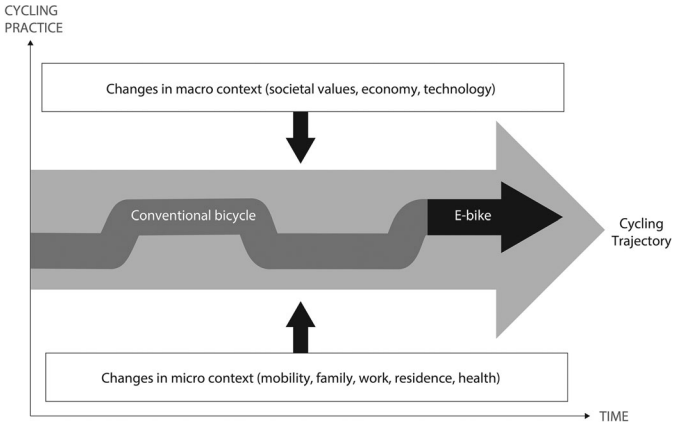

Figure 1. Cycling trajectory—adapted from H. Jones et al. (2015).

in life course studies, which have been used in sociology, psychology, health and migration studies, and see current behavior as the cumulative outcome of a trajectory of past behavior across the life course (Elder et al., 2003). As put forward by Giele and Elder (1998): *"Any point in the life span must be viewed dynamically as the consequence of past experience and future expectation as well as the integration of individual motive with external constraint"*.

Building on this, the field of mobility biographies research (for a review, see Müggenburg et al., 2015) considers an individual's longitudinal trajectory in the mobility domain as embedded within other domains of life such as lifestyle and accessibility (Lanzendorf, 2003), or employment, household, and residence (Scheiner, 2007). Mobility biographies research has mostly focused on the role of "key events", specific moments in the life course which trigger a reconsideration of habitual travel behavior (Klöckner, 2004, p. 2). Müggenburg et al. (2015) distinguish between "life events" which are strictly outside the scope of transport such as childbirth, "long-term mobility decisions" such as residential relocation or vehicle ownership, "exogenous interventions" including road closures or incentives, and "long-term processes in life" of socialization linked to age, cohort, or historical period.

However, some authors have contended that this focus on key events is too narrow, because it does not capture the full extent of mobility processes across the life course, particularly the social and cultural meanings of mobility practices (Sattlegger & Rau, 2016). As a result, a few studies, notably in the domain of cycling, have moved beyond key events to include the study of long-term trajectories of mobility (Chatterjee et al., 2013; H. Jones et al., 2014).

2.2. Biographical approaches to cycling

Research on cycling has mainly focused on the role of specific determinants in explaining the propensity to cycle (Handy et al., 2010; Heinen et al., 2010). Although most research on cycling is cross-sectional, a few studies have adopted a biographical perspective to study the variations in cycling over the life course.

Several studies have found changes in cycling to be triggered by key events in the life course (or external events according to Chatterjee et al., 2012), which can either force a reconsideration of travel behavior, change the social environment and norms around cycling, unleash a latent demand for cycling, or trigger new destinations and interest in cycling (Janke & Handy, 2019). Contextual changes in place of residence, workplace or education have especially been linked to changes in cycling (Chatterjee et al., 2013; Janke & Handy, 2019; Oakil et al., 2016). In particular, shortening the commute distance has a strong impact on switching to cycling (Oakil et al., 2016). Personal changes like friendships, meeting a new partner, and parenthood are also linked to changes in cycling, both increases in cycling as a social or familial activity, or decreases due to lack of time or interest (Bonham & Wilson, 2012; Janke & Handy, 2019).

Cycling is affected differently by events at specific life stages. A major interruption of cycling seems to occur at adolescence as the perception of cycling shifts negatively with the onset of driving in automobile-oriented societies (Bonham & Wilson, 2012; Underwood et al., 2014). In other countries where a decline in youth licensing is observed (Rérat, 2018), public transport seems to represent the main competitor to cycling. At adulthood, residential, workplace and relationship changes affect cycling most, with parenthood affecting women in particular (Bonham & Wilson, 2012; Janke & Handy, 2019). Later in life, health concerns are especially linked to changes in cycling, both as a leisure activity, but also because of interruptions due to injury or physical limitations (Bonham & Wilson, 2012).

2.3. Conceptual framework: the cycling trajectory

Rather than focusing on specific events, analyzing individual variations in cycling over the whole life course leads to the consideration of cycling trajectories. Bonham and Wilson (2012) used women's "personal histories of cycling" to show multiple attemps to return to cycling over the life course, despite frequent interruptions.

The concept of cycling trajectory is the application of a life course approach to cycling. According to Chatterjee et al. (2012), it represents "*a person's thoughts, feelings, capabilities and actions related to cycling […] developed over the course of their lives and shaped by transitions (or life-change events) that they have made and the contexts that they encounter*" (Chatterjee et al., 2012: 5).

Our conceptual framework in this paper is inspired by the one used by H. Jones and colleagues (H. Jones, 2013; H. Jones et al., 2014, 2015) and presented in Figure 1. The cycling trajectory is seen as influenced by a micro context which refers to key events in the domain of mobility, family, work, residence and health, as well as a macro context which includes societal, spatial, economic and technological developments in transport over time. It adapts H. Jones et al. (2015) by including both conventional cycling and e-bike use as part of the same cycling trajectory. The focus of this paper is specifically on the cycling trajectory itself, although some contextual elements for the setting of the study are briefly described in the methodology.

2.4. E-bikes and cycling

Research on e-bikes is recent but the context has changed much since the first studies on the topic (Cherry & Cervero, 2007; Weinert et al., 2007). We will not attempt a full review of the literature as this has already been undertaken (Fishman & Cherry, 2016). Instead, we focus on e-bike users, their mobility practices and their relationship to cycling.

Due to their electrical assistance, e-bikes may open up cycling to a larger spectrum of users compared to conventional bicycles, while also acting as an "equalizer" between the cycling levels of individuals (Popovich et al., 2014). Indeed, a defining trait of e-bike users seems to be their higher age, as individuals between 50 and 65 years old are overrepresented (Johnson & Rose, 2013; MacArthur et al., 2014; Simsekoglu & Klöckner, 2019; de Kruijf et al., 2019), although few studies report a majority of retired users (Wolf & Seebauer, 2014). E-bike users live in households mostly composed of families or couples, with income and education levels above average (Johnson & Rose, 2013; MacArthur et al., 2014; Wolf & Seebauer, 2014). Barriers of price and image may explain why younger adults under the age of 25 are rare. The gender makeup of e-bike users is more balanced than for cycling, particularly in cycle-friendly countries like Denmark or the Netherlands where women are a majority among e-bike users (Haustein & Møller, 2016), although this is not the case in countries such as the United States or Australia (Johnson & Rose, 2013; MacArthur et al., 2014).

Research on the health benefits of e-bikes shows that despite an electrical assistance, they still manage to provide a meaningful amount of physical activity (Bourne et al., 2018), especially when compared to non-active modes of travel such as car use. Crucially, they may contribute to better health and mobility for ageing users (Johnson & Rose, 2015; Jones, Chatterjee, et al., 2016; Van Cauwenberg et al., 2019), although the benefits of active mobility also extend to a broader spectrum of the population in the context of an increasingly sedentary lifestyle. In addition to physical activity, e-bikes have also been linked to healthy ageing as they improve cognitive functions and mental health through engagement with the outdoor environment, independence and mobility (Leyland et al., 2019; Spencer et al., 2019). However, their negative health effects include a higher risk of accident compared to conventional cycling, presumably due to the increased weight and speed of e-bikes (Schepers et al., 2014)

E-bikes may also allow for longer trips than conventional bicycles. According to the literature, switching to an e-bike mostly affects car use or conventional cycling (Fishman & Cherry, 2016), depending on the dominant forms of mobility in the setting of the study. In car-centered contexts like North America or Australia, the e-bike is considered as a way to reduce the use of the car (Dill & Rose, 2012; Edge et al., 2018; Johnson & Rose, 2013; MacArthur et al., 2014; Popovich et al., 2014), though this result has also been found in Norway (Simsekoglu & Klöckner, 2019) and Sweden (Hiselius & Svensson, 2017). Conversely, the e-bike mostly substitutes conventional cycling in countries where the population is already cycling at a high rate, such as in Denmark (Haustein & Møller, 2016) or the Netherlands (Lee et al., 2015[2]), or for retired, leisure users, in Austria (Wolf & Seebauer, 2014). Although a switch from car use is more beneficial in environmental terms than one from conventional cycling (Rose, 2012), both are positive as studies show a reported increase in the volume and duration of trips with e-bikes compared to conventional bicycles (Fyhri & Fearnley, 2015; Kroesen, 2017; Ling et al., 2017).

Most studies consider e-bike use and conventional cycling as two separate practices. By doing so, they do not explicitly address the long-term cycling trajectory of e-bike users. Nonetheless, a few qualitative studies have investigated the previous experience that e-bike users have of conventional cycling. Almost all e-bike users seem to have practiced conventional cycling at some point of their youth, or during their adult life, although many interrupted their practice (Le Bris, 2016; Leger et al., 2019). Le Bris (2016) finds the purchase of the e-bike to have either the objective of the conservation, reactivation or facilitation of an existing cycling practice. More generally, there seem to be two main types of e-bike users. Those who already cycled regularly before acquiring an e-bike and wish to maintain cycling or return to it, and those who did not cycle (Jones, Harms, et al., 2016).

We argue that there is a need for additional research on e-bike users' long-term relationship to conventional cycling. To do so, we will consider both conventional cycling and e-bike use as part of the same cycling trajectory over the life course.

3. Methodology

3.1. Case study

The present study was conducted in Lausanne, the fourth-largest city in Switzerland with a population of 140'000 inhabitants (Canton of Vaud, 2018) and an urban area of about 415'000 inhabitants in 2017 (Federal Statistical Office, 2018). The city has the particularity of being notoriously hilly and has the lowest mode share of cycling among large cities in Switzerland, with only 1.6% of trips made by bicycle in 2015 (Federal Statistical Office & Federal Office for Spatial Development, 2017). It has been ranked the least safe city for cyclists among 24 cities in the country (Rérat et al., 2019)[3]. In the 2015 census, 3.1% of the households in the city owned an e-bike, compared to an average of 7% on the national level (Federal Statistical Office & Federal Office for Spatial Development, 2017). Similarly, only 41.7% of households owned a conventional bicycle, which is lower than the rate of 65% observed nationally (ibid.). Car ownership

[2]Another study in the Netherlands found that e-bikes substituted for car and public transport trips, but concerned a small sample of commuters living outside a city center (Plazier et al., 2017).

[3]A national survey conducted in 2016 among 54'000 participants to a program called "Bike to work" found 34% of respondents in Lausanne reported they did not feel safe while cycling, compared to 14% on average nationally.

Table 1. Characteristics of e-bike users (N = 24).

User No.	Name (fictional)	Age	Employment Status	E-bikes owned	Bicycles owned	Cars In household
1	Pascal	51	Employed full-time	2 or more	2 or more	1
2	Philippe	55	Employed full-time	1	1	None
3	Marie	36	Employed full-time	1	None	None
4	Sébastien	29	Employed full-time	1	2 or more	None
5	Nicole	42	Employed part-time	1	1	1
6	David	25	Student	1	2 or more	None
7	Hélène	36	Employed full-time	2 or more	None	1
8	Pierre	43	Employed full-time	1	2 or more	1
9	Denis	52	Employed full-time	1	2 or more	1
10	Laure	52	Employed full-time	1	1	None
11	Paul	30	Employed full-time	1	1	None
12	Claudine	50	Employed full-time	1	None	None
13	Sarah	33	Employed part-time	1	1	None
14	Daniel	34	Employed full-time	2 or more	None	None
15	Stéphanie	38	Employed part-time	2 or more	1	None
16	Lucas	40	Unemployed	1	None	None
17	Jacques	61	Employed full-time	2 or more	2 or more	2 or more
18	Christine	65	Retired	2 or more	1	1
19	Céline	69	Retired	1	None	1
20	Michèle	76	Retired	2 or more	1	2 or more
21	Robert	79	Retired	2 or more	1	None
22	Jean	69	Retired	1	1	2 or more
23	Hubert	80	Retired	1	1	1
24	Michel	70	Retired	1	1	1

reached 53.7% of households compared to 78% nationally (ibid.). This difficult setting thus offers an interesting case study for e-bike adoption, which might be able to overcome some limitations of the city in terms of topography and bicycle infrastructure.

Our qualitative data comes from a sample of e-bike users (N = 24), recruited among the beneficiaries of a municipal subsidy for the purchase of an e-bike from the city of Lausanne[4]. Twenty of them were selected among a broader set of participants to an online and postal survey of e-bike users[5]. Meanwhile, four additional users were recruited through staff and students on the campus of the University of Lausanne. The resulting sample was meant to illustrate the diversity of situations of e-bike users in terms of age and gender. Table 1 shows the age, employment status and mobility equipment of our respondents. They include 14 men and 10 women, with ages ranging from 25 to 81 years old at the time of the interview. A high proportion of users had a tertiary education, and most were professionally active, which reflects results from other studies, including our own quantitative survey. Eight users out of twenty-four had owned several e-bikes and the date of purchase of the first e-bike ranged from 1996 to 2018, although only four users had owned an e-bike for longer than 10 years. In addition to an e-bike, eighteen users out of 24 (75%) indicated owning a conventional bicycle, a higher proportion than in the municipal population. Additionally, only half (12 out of 24) had a car available in their household, which is slightly more than households in the urban municipality.

Our qualitative sample covered diverse situations of e-bike use, but shows some differences compared to the survey of e-bike users we conducted in Lausanne, which included a small majority of women (53%), fewer users over 60 years (19%), and a larger proportion of users between 40 and 59 years of age (45%). While our sample includes more experienced, long-time users who have owned several e-bikes, the survey indicates that two thirds of e-bike users in Lausanne are recent, having only made their purchase in the last two years. We discuss the further implications of this sample for the generalization of our results in section 5.

3.2. Interviews

Retrospective biographical interviews were conducted for approximately one hour and covered both the long-term relationship to cycling over the life course and the short-term period around the purchase of the e-bike. While quantitative data has been used to study the timing of biographical events and variations in travel behavior, some authors suggest the complexity of influences and decision processes during these events is more suited to qualitative analysis (Lanzendorf, 2003; Müggenburg et al., 2015). In line with so-called narrative approaches to mobility biographies, we chose to use semi-structured interviews rather than life course calendars, which allow a more inductive data collection and a focus on changes in meaning over time, rather than on linear sequences of events (Sattlegger & Rau, 2016).

Although using a retrospective approach implies a recall bias, qualitative data forces respondents to give more detailed information and can provide a better recollection of events than quantitative data (Behrens & Mistro, 2010; Beige & Axhausen, 2008; Lanzendorf, 2010; Oakil et al., 2016). Additionally, our focus on the purchase of the e-bike was generally helpful as this moment was recalled well by most of our interviewees and had taken place only few years prior. Using the date of purchase of the first e-bike as a

[4]The subsidy has existed since the year 2000. At the time of survey, it covered 15% of the price of an e-bike, with a maximum of 500 swiss francs. Its conditions are widely known and promoted to customers by bicycle shops in the region, and as such it applies to all buyers of a new e-bike residing in the city. An additional subsidy is also available for the purchase of an e-bike battery (100 swiss francs).

[5]A quantitative survey targeted over 3,400 users in the city and yielded 1,466 responses. Among them, 717 users agreed to be contacted for interviews.

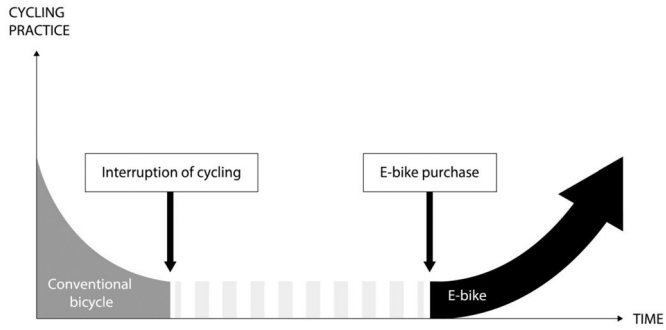

Figure 2. Restorative cycling trajectory. Source: Authors.

point of reference was found to be useful to activate discourse on mobility practices before and after the purchase of the e-bike. As can be expected, the recollection of events leading to the purchase of the first e-bike was easier for people who had recently purchased it than for more experienced users who had owned multiple e-bikes. The latter were also prone to mixing motivations for the first purchase with more specific technical requirements for later vehicles.

Our interview guide included five parts: a description of the household and its mobility equipment, of the adoption of the e-bike, the long-term relationship to cycling and other transport modes, of travel behavior before and after purchase of the e-bike, and of the experience of using the e-bike. The resulting interviews were transcribed and coded with the software Atlas.Ti. Individual cycling trajectories were constructed, which consisted in a timeline of periods of bicycle and e-bike use, as well as specific dates for biographical events. The trajectories were then classified on the basis of the following criteria: (1) the presence of a significant period (minimum one year) of interruption in cycling practice in the years before the purchase of the e-bike, (2) the perceived frequency of cycling at the time of purchase of the e-bike and its variation throughout the life course, (3) the type of cycling practiced, with a distinction between transport or utilitarian trips taken in relation to other activities, and sports or leisure trips taken for their own sake.

Following H. Jones et al. (2015) who categorized trajectories depending on their evolution, "resilient" or stable, "restorative" or increasing, and "diminishing", we distinguish between two main types of cycling trajectories: resilient and restorative trajectories. Diminishing trajectories are not included as they are not found in the case of the e-bike users we interviewed, because the e-bike purchase always resulted in an increase in cycling[6]. The e-bike users who were not cycling regularly for transport at the time of the purchase of the e-bike, or had experienced an interruption in their cycling practice in the years before, were considered as having a restorative trajectory. Those who indicated that they had been regularly cycling for transport before buying an e-bike and did not experience an interruption in their cycling practice in the last years were considered to have a resilient trajectory.

[6]The survey tends to confirm this as only 0.6% of respondents stated that they "never" use their e-bike. As former e-bike users may be less likely to respond, this share could be higher but still represents a small minority.

4. The cycling trajectories of e-bike users

Our results are structured in two parts corresponding to the two cycling trajectories. For each cycling trajectory, we describe the general characteristics and subcategories and give examples of individual e-bike users.

4.1. Restorative trajectories: Using the e-bike to restart cycling

Restorative trajectories account for 14 users out of a total of 24 (58%). They correspond to e-bike users who, at the time of the purchase of the e-bike, were not cycling for transport anymore. The effect of purchasing an e-bike was to restore a regular cycling practice, as represented in Figure 2.

Though they knew how to ride a bicycle, some e-bike users had never done so regularly, while others had cycled during youth before interrupting this practice. Interruptions to cycling mostly occurred in favor of other modes of transport, most often car use. They were linked to work obligations, and for women in particular, to parental duties while raising their children, confirming other studies (Bonham & Wilson, 2012). During this period of interruption, some users did not own a bicycle anymore, while others still cycled occasionally for recreation, as the dashed line in Figure 2 represents. This trajectory includes three subcategories, depending on the level of cycling practiced before the adoption of the e-bike: *returning to cycling (1)*, *starting to cycle for transport (2)*, or *continuing a return to cycling (3)*.

4.1.1. Returning to cycling

The first category of users (no. 01, 04, 09, 23, 24) had cycled regularly for transport at some point during their life course before interrupting this practice for a period of several years. The wish to practice physical activity and preserve one's health was often cited as an important motivation in adopting the e-bike, especially for middle-aged users. The adoption of the e-bike had the effect of restoring their cycling practice to a level similar or higher than previously. An example of this is Denis (52), who used to cycle to work when he was younger and living abroad. He had stopped cycling since moving to the city because the gradient made it too difficult to do so with a conventional bicycle. He adopted an e-bike as a way of doing some exercise and in order to bring his children to school without driving them by car:

> [Denis, 52] "Before, I always used to cycle. When I was in [another city], it was flat, and in [another city] as well. I went to school by bike as a kid. I always cycled to get around, never as a sport but as a way to move around. But in Lausanne, working downhill when you live uphill, some hills are really steep, like the road in front of our home. So, I hesitated for a long time, and then I thought an e-bike would not be bad and would help me avoid using the car "

4.1.2. Starting to cycle for transport

The second category of users (no. 02, 05, 14, 16, 18) considered themselves non-cyclists and had never cycled

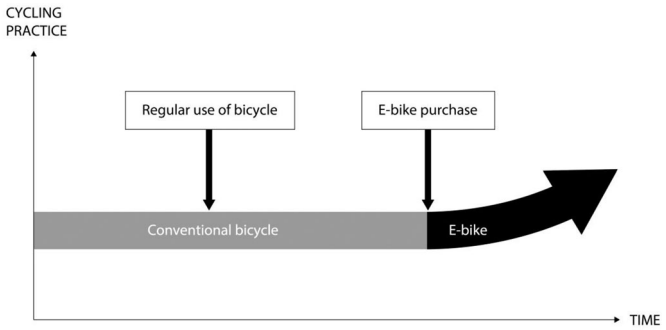

Figure 3. Resilient cycling trajectory. Source: Authors.

regularly. Their adoption of the e-bike was motivated in part by the practicality of the e-bike and a frustration with car use in an urban setting. An example of this is Daniel (34), who used to drive for work and rode a scooter (motorized two-wheeler). Coming from a rural region, he did not cycle at all before moving to the city. When he changed job to a location closer to the city center, using the car become too cumbersome because of traffic and parking restrictions. As he was simultaneously becoming a father, he took the opportunity to sell his car and bought an e-bike to go to work and carry his child. He also got rid of his scooter. Although his example of a switch to the e-bike goes with a larger transition in his lifestyle, he considers the e-bike as something different than conventional cycling.

> [Interviewer] " Did you cycle before [purchasing the e-bike]?"
>
> [Daniel, 34] "No, I didn't cycle at all before."
>
> [Interviewer] "How did the idea of cycling come to you?"
>
> [Daniel, 34] "It wasn't really cycling, in reality. I like the freedom that cycling gives you. I also have a scooter that I had more trouble giving up. I wanted to get rid of the car and keep the scooter. But after a few months, I also decided to sell my scooter. I've given it to a friend for now, because I don't use it anymore."

4.1.3. Continuing *a return to cycling*

After stopping cycling for several years, the third category of users (no. 07, 17, 19, 22) had attempted to return to cycling with a conventional bicycle, before switching to the e-bike. Their use of conventional cycling was generally limited and complemented by other modes such as public transport. Adopting the e-bike was seen from the viewpoint of the conventional bicycle as a way to make cycling easier. It had the effect of continuing a return to cycling that had already been started. An example of this trajectory is Jacques (61), who used to cycle for sport and as a commuter when he lived in another city, before interrupting cycling. Following a heart disease, he returned to conventional cycling as a less intensive form of exercise. He decided to switch to an e-bike due to his physical condition, as he felt he could not hold up anymore when cycling with his partner. This pushed him to cycle more regularly to work.

> [Jacques, 61] "We talked about it with my partner because we noticed in our [bicycle] tours that I was having more and more trouble. She also had knee problems, so she bought her [e-bike] first. We noticed that we were not performing as well as before and that's what decided us."

Restorative trajectories show that the e-bike constitutes, for many users, a return to a cycling practice that is less demanding than conventional cycling. In this sense, the e-bike has been called a "transitional step" toward cycling (Popovich et al., 2014). The subcategories of resilient trajectories reflect differences in the amount of conventional cycling practiced before acquiring an e-bike. While some e-bike users are indeed new to cycling, most had already cycled regularly at some point of their life, even though they had stopped before purchasing an e-bike. The third sub-category also indicates that some attempts to return to cycling had been made after an interruption (similar to Bonham & Wilson, 2012), which were then continued with the e-bike.

4.2. Resilient trajectories: Maintaining cycling with the e-bike

Resilient trajectories are the second group of cycling trajectories linked to the e-bike. They include 10 users out of 24 (42%). In contrast to restorative trajectories, these people were already cycling regularly before purchasing an e-bike and maintained their practice over time (Figure 3). The e-bike was chosen specifically for its electrical assistance, as a way of maintaining a cycling practice despite contextual changes such as residential and work relocations, childbirth, and ageing and diminishing physical capacities.

A common characteristic among resilient trajectories is that cycling was already their main mode of transport. A majority of users with resilient trajectories (8 out of 10) did not own a car, or had given it up. Living car-free can explain the continued importance of cycling as their main mode of transport. Cycling was seen as more than a physical activity, a mode of transport affording freedom of movement and autonomy to access the places of everyday life.

Resilient trajectories can be distinguished according to whether conventional cycling remained practiced alongside the e-bike. Depending on this, we find two subcategories of resilient trajectories: (1) *Replacing conventional cycling by the e-bike* and (2) *Alternating conventional cycling and the e-bike.*

4.2.1. Replacing conventional cycling by the e-bike

For the first category of users (no. 03, 10, 12, 15, 20, 21), purchasing an e-bike led to a complete replacement of their conventional bicycle. They saw the e-bike as essentially the same practice as conventional cycling, even referring to it as their "bicycle". Their switch to an e-bike was motivated by the difficulty of cycling because of the gradient, the need to carry children, or the increase of age. While some had given up or sold their conventional bicycle as a result, others had kept it but did not use it anymore. An example of this is Stéphanie (38), who used to cycle in another city and never owned a car. She moved to Lausanne and started using a conventional bicycle for work trips. When she was expecting her first child, she decided she would need an e-bike to keep cycling because of the additional weight, and bought an e-bike.

[Stéphanie, 38] "The idea [of buying an e-bike] came with my pregnancy, I thought how am I going to carry my baby? […]. As soon as I saw the e-bike I thought it was what I needed to carry my child by bicycle, otherwise I wouldn't manage in Lausanne. In [another city] it would have been logical to use a child seat on a normal bicycle, but here it wasn't. So, I found a way to make it work."

4.2.2. Alternating conventional cycling and the e-bike

The second category of users (no. 06, 08, 11, 13) continued to use a conventional bicycle alongside an e-bike. Having a strong attachment to conventional cycling, they viewed the e-bike not as a replacement, but rather a complement to it. Although they justified its adoption by the topography of the city, they considered it a form of "cheating" compared to conventional cycling. Some users switched between an e-bike and a conventional bicycle depending on the type of trip (utility or sport), the level of fatigue or the weather, with the lighter, conventional bicycle more suited to warm summer months while the e-bike was preferred in winter. An example of this trajectory is Paul (30), who did not own a car and had been a regular cyclist for transport for many years. When he moved out of the city center to the suburbs, he decided to purchase an e-bike as a way of staying independent from public transport. He insisted on keeping his conventional bicycle to alternate with the e-bike in the summer months.

[Paul, 30] "I wanted to keep my independence for longer during the year, because as soon as the weather gets cold, a regular bicycle is annoying because you sweat, it's unpleasant […]. E-bikes are well-built and comfortable with larger tires, so even when it rains, though maybe not if it's snowing, but almost all year I can cycle. That's the main reason why I bought an e-bike."

Resilient trajectories and their subcategories show that e-bike use and conventional cycling are both part of the same practice. For these users with a strong bond to cycling, adopting the e-bike is a way of maintaining cycling, even when circumstances would make conventional cycling difficult. This trajectory also shows that the e-bike does not necessarily replace conventional cycling, as both can be complementary to one another. However, despite their limitations and the effort they require, conventional bicycles retain specific advantages over e-bikes, for example as a form of exercise, as the following quote by Sarah (33) shows.

[Sarah, 33] "It's special because with the e-bike I don't feel like I'm doing exercise. Since I'm used to a real bike and I also exercise in my free time, it's not … Yes, it makes me move a bit, it's certainly better than doing nothing but I don't consider it as exercise. This feeling of freedom and well-being, I have it more with a real bicycle, that's also why I keep using one as much as I can in the summer."

5. Discussion

The e-bike offers an insight into the adoption of a new mode of transport, but also into the long-term relationship people have to cycling. Existing literature on the e-bike tends to adopt a cross-sectional rather than biographical approach. Most studies do not specifically address e-bike users' past experience of cycling, although it may explain current e-bike use. In this paper, we have tried to fill this research gap, by applying the concept of cycling trajectory (Chatterjee et al., 2012; H. Jones et al., 2015) to include the practice of conventional cycling, and electrically-assisted cycling, over the life course. Our study aimed to question how the sub-practice of the e-bike fits into an existing conventional cycling practice.

Our results confirm that the purchase of an e-bike is part of a longer process that stretches throughout the life course and links with conventional cycling. E-bike users have different cycling trajectories, which we categorized following H. Jones et al. (2015) as either "restorative", where the e-bike constitutes a return to cycling, or "resilient", where it is a continuation of conventional cycling. Resilient and restorative cycling trajectories represent two different relationships to cycling.

For restorative trajectories, the e-bike constitutes a return to cycling after an interruption of several years, or a way to start cycling for transport. E-bike users with this trajectory either did not cycle or interrupted cycling for various reasons among which work obligations or child care, with cycling overshadowed by other mobility practices like car use and public transport. Their motivation to adopt the e-bike was often linked to the wish to take up a physical activity which was less demanding than conventional cycling. This relates to the findings of other studies that the e-bike minimizes stress on the body for people with injuries (Johnson & Rose, 2015; Jones, Harms, et al., 2016; Leger et al., 2019). Among restorative trajectories, the e-bike may be used as a return to cycling after an interruption, as a way to start cycling for transport, or as a continuation of a return to cycling that had already begun previously. This shows that different forms of returns to cycling may exist, as shown by Bonham and Wilson (2012).

For resilient trajectories, the e-bike was adopted as a continuation of an uninterrupted conventional cycling practice. For people who saw cycling as their main mode of transport, the e-bike represented a way of preserving this practice despite challenges posed by biographical changes like childbirth or the advance of age, and changes in spatial context which made it difficult to keep cycling. Our findings confirm that switching from a conventional bicycle to an e-bike can be an "adaptive" change in order to maintain cycling (H. Jones et al., 2015), or to avoid interrupting cycling due to a decline in health or physical ability (Jones, Harms, et al., 2016; Leger et al., 2019). Among resilient trajectories, there are users who entirely replaced their conventional bicycle by an e-bike, while others alternate between using both. These subcategories show how both e-biking and conventional cycling are closely related, and, in fact, part of the same practice.

Overall, cycling trajectories demonstrate the influence of biographical and contextual changes on the adoption of e-bikes. These changes can both act as opportunities for

returning to cycling, or as threats to its continuation. This parallels the finding of Bonham and Wilson (2012), who noted the "circularity" of cycling and its tendency to return at various moments of life. By removing barriers to conventional cycling linked to distance, physical effort, or weight, the e-bike could play a role in reducing interruptions to cycling during the life course. However, e-bikes will not solve everything, and interruptions to cycling may also be due to an unsupportive cycling environment. Both maintaining and attracting e-bike users requires cycle friendly infrastructures which must satisfy criteria of cohesion, directness, attractiveness, safety and comfort (CROW, 2016).

The choice of a qualitative sample allowed us to gain an in-depth appreciation of the diversity of personal situations of e-bike users. However, this also means the proportions we found for restorative (58%) and resilient trajectories (42%) are not exactly representative. Our questionnaire survey among the population of e-bike users in Lausanne actually found restorative trajectories to account for about 3 e-bike users out of 4 (73%), whereas resilient trajectories represented 1 in 4 users (27%).

It is likely that the proportions of these two trajectories (restorative and resilient) may differ in other contexts. In Denmark, Haustein and Møller (2016) found that close to half of e-bike users previously cycled several times a week, while 1 out of 4 did so less than once per month, suggesting a higher part of resilient trajectories. Similarly, in the Netherlands and Great Britain, Jones, Chatterjee, et al. (2016) found that half of the interviewed e-bikers previously used conventional cycling as their main mode of travel.

One possible explanation for the observed differences may be the particularly hilly setting of Lausanne, and its low modal share of cycling. Other studies may find different characteristics for e-bike users depending on the ease of practicing conventional cycling due to topography, cycling infrastructure or cycling culture. This was acknowledged by some e-bike users who maintained that they would go back to conventional cycling if they lived in a flatter city. For example, younger individuals who would not need to use an e-bike elsewhere might be overrepresented in Lausanne, while difficult cycling conditions might lead to underrepresenting older e-bike users.

Future research should strive for a better understanding of the diversity of e-bike users. This implies studying the cycling trajectories of e-bike users in different spatial or topographical settings, as well as different cycling environments. One area that presents much potential for e-bike research is in suburban and rural settings, where the development of e-bikes has been higher than in urban areas (for Switzerland, see Ravalet et al., 2019).

6. Conclusion

With increasing sales and availability of data on e-bike users, the future development of e-bikes presents an interesting avenue for research. Ongoing trends in cycling might change the proportions of cycling trajectories. E-bikes have been increasingly diffusing, attracting women and younger users, and moving away from their initial audience of elderly cyclists (Peine et al., 2017; Ravalet et al., 2019). Meanwhile, an increase in overall levels of cycling (Buehler & Pucher, 2012) coupled with receding car ownership among young adults (Rérat, 2018) can be expected to increase the number of resilient cyclists, who are at present a minority, over time.

Moving beyond conventional, cross-sectional approaches of individual modal choice, biographical approaches to mobility have forced us to rethink the way mobility changes over time through key events and the influence of social, familial and historical contexts. The study of mobility trajectories may be a useful tool to visualize and analyze how past experiences can influence mobility behavior over time. Cycling trajectories offer the possibility to view cycling as a long-term practice over the life course rather than just a daily decision. This may offer a more realistic view of cycling, which has been systematically underestimated because of its short trips, and the difficulty of categorizing leisure and utility trips. By extending the possibilities of cycling in terms of distance, physical effort, age, and carrying capacity, but also, by maintaining cycling over time, the emergence of e-bikes may fit the needs of a larger spectrum of people who would otherwise not cycle. Rather than opposing conventional and electrically-assisted cycling, and the sustainability of a switch from one to the other, e-bikes should therefore be seen as an opportunity to enlarge the potential of cycling.

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