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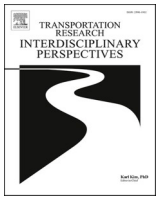

Build it and they will come? The effects of a new infrastructure on cycling practices and experiences

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ABSTRACT

What are the effects of cycling infrastructure? This question is crucial as cities begin to give more space to cycling. In this paper, we propose to use the theoretical concept of affordance to consider not only *what* a cycle lane affords (or enables), but also *how* it does this and *for whom*. This has led us to consider three dimensions: (1) the number of cyclists using a route, (2) their characteristics and (3) their experience of cycling. We adopt an approach that combines counting, observation, and intercept surveys both before and then one year after the installation of a new 1.1 km cycle lane in Fribourg, Switzerland. A large increase in cycling traffic following the introduction of the cycle lane (+20 % on weekdays) reveals a latent demand that has been triggered by an improvement in cycling infrastructure. While the characteristics of cyclists (age, gender, etc.) did not fundamentally change, there was a clear improvement in the experience of cycling, particularly in terms of feeling safe. This effect is important, as developing cycling is not only about attracting new users but also reinforcing potentially fragile existing practices. Nonetheless, for a minority of users, the new infrastructure still does not meet safety expectations, and the lack of cycling amenities in the rest of the town limits the expansion of cycling. The approach we have designed could be replicated in other contexts by researchers, advocates, or professionals in order to obtain comparative data on cycling infrastructure.

1. Introduction

Developing cycling as a mode of transport involves rethinking streetscapes and reallocating space from motorised vehicles. The effect of cycling infrastructure has been summarized by the slogan, "Build it and they will come!". But are things so clear? What is their effect on cycling traffic? Who cycles more if they are provided with new infrastructures? How does the embodied experience of cycling evolve?

These questions are crucial as cities try to give more space to cycling while dealing with debates arising from those that contest cycling-friendly policies such as car lobbies, right-wing parties and retailers (see Rérat and Ravalet, 2022). Some cycling scholars argue that it is necessary to look beyond physical infrastructure ("hard" measures) and consider human infrastructure (attitudes and cultural values related to cycling) and "soft" measures (campaigns, cycling classes, etc.) (e.g. Snaije and Nosowicz, 2022). Yet there is a lack of data that compares cycling practices before and after the installation of cycling infrastructure, making it difficult for researchers and policymakers to evaluate the effectiveness of cycling interventions (Félix,Cambra,and Moura, 2020).

This paper analyses a new cycle lane in Fribourg, Switzerland, and brings added value to the debates on cycling infrastructure theoretically, methodologically, and empirically.

From a theoretical perspective, we conceptualize the effects of cycling infrastructure through the concept of affordance (Davis, 2020; Davis and Chouinard, 2016), which derives from the verb 'to afford' and connotes both provision and ability to do something. This theoretical lens argues for the consideration not only of what an artefact (e.g. an infrastructure) affords (such as the volume of cycling and its evolution) but also the mechanisms of this affordance (how it enables more cycling) and the conditions (for whom). This led us to consider three dimensions in the assessment of cycling infrastructure: (1) the number of cyclists that use the infrastructures provided, (2) their characteristics, and (3) their experience of using those infrastructures.

Methodologically, while existing research has focused on either the evolution of cycling traffic or the quality of a route at a specific time (see below), we were able to collect longitudinal data by combining counting, observation, and intercept surveys before and after the infrastructure was built.

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Empirically, our data revealed a strong increase in cycling after the introduction of the cycle lane, indicating a latent demand. The main mechanism of this is a clear improvement in the experience of riding and perceived safety. Cycling policy should aim not only to attract new users but also to help maintain and/or reinforce existing practices. However, the lack of cycling amenities in Fribourg still limits the expansion and diversification of cycling.

The paper starts by discussing the way cycling infrastructure are addressed in the literature and by conceptualizing the effects of cycling infrastructure through the lens of affordance. We then discuss the literature according to whether the focus is on numbers (does infrastructure increase the number of cyclists?), characteristics (does infrastructure extend and diversify the practice of cycling?) or experience (does infrastructure improve the experience of cyclists?). Section 3 presents the research design, and Section 4 discusses changes following the intervention in terms of the number of cyclists, their characteristics, and their experience. Finally, the conclusion summarizes the main results and highlights the need to include users' perspectives in cycling research and policy.

2. Theoretical discussion

2.1. Addressing cycling infrastructure

Cycling infrastructure is often seen – both in academic studies and in advocacy – as a key lever to make cycling a fully-fledged mode of transport and to unlock its potential. The issue of cycling infrastructure is researched mainly through two perspectives: the planning and production of infrastructure (which could be referred to as a macro scale) and the way users experience them (micro scale).[1]

The first perspective calls for political analyses of infrastructure. It highlights the fact that each implementation is preceded by a "history of power games" (Cox and Koglin, 2019, 11) and that infrastructure gives material expression to ideology (p. 6). Transport systems and roads are dominated by motorized traffic in almost all countries and cycling infrastructure (or the lack thereof) should not be treated "as a given, subject only to appropriate design and implementation" but rather as "a product of political contestation" (ibid. 2). It is therefore necessary to understand how and why cycling remains marginalised in many transport systems and how this marginalisation relates to the motorised transport dominance (Koglin and Rye, 2014). This dominance has notably been addressed through the concept of automobility (Urry, 2004) to highlight the fact that the car is much more than a vehicle but also refers to a socio-technic assemblage involving practices, infrastructure, social norms, images, rules, industries, etc. In contrast, velomobility can be regarded as an incomplete system that lacks dedicated infrastructure and social legitimacy in a context dominated by automobility (Cox, 2019), as both systems "compete for people's time, for road space, for resources, and in discourse" (Watson, 2013, 121).

A second range of literature deals with the practices through which infrastructure are used and aims to understand the users' perspective. Some work addresses the way cyclists accommodate themselves to (and are in turn accommodated by) the infrastructural orderings of road infrastructure designed primarily for motorised traffic (e.g. Latham and Wood, 2015). Other research – discussed more in detail below – either assesses the quality of a cycling route or the evolution of cycling traffic in relation to an intervention such as a new infrastructure. Lastly, others highlight the varying needs among the population according to gender, age, skills, motivations, etc. (e.g. Dill and McNeil, 2013).

In this paper, we draw on the concept of affordance to propose a theoretical framework and empirical methods to assess the effects of (new) cycling infrastructure. We argue that considering users' experience is important to understand who cycles or not in a spatial context and to assess the benefits and limits of various interventions.

2.2. Conceptualizing cycling as affordance

Beyond its simplicity, the slogan "Build it and they will come!" raises several questions: What is "it" (i.e. what kind of infrastructure)? Who are "they" (i.e. who cycles more or starts to cycle)? Why do they come (i.e. what makes them cycle or cycle more)? The concept of affordance provides a theoretical framework to address these dimensions.

Affordance was first defined by Gibson, an ecological psychologist, as representing the opportunities for action provided by an environment. Affordances are relational structures of the environment available to be perceived (Gibson, 1979) which offer opportunities for action. Affordance has been debated in ecological psychology (e.g. Jones, 2018) and has also been used in other fields such as design studies to address human–machine interactions and to design objects guiding users' perceptions and actions (Norman, 1990). It is now applied in many disciplines as "the multifaceted relational structure between an object/technology and the use that enables or constrains potential behavioral outcomes in a particular context" (Davis, 2020, 6).

We apply Davis' definition of affordance – which she applies to the design of physical objects and virtual tools – to cycling. We argue that the five principles she identifies are particularly relevant to address the effects of infrastructure on cycling: (1) relationality (between artefacts and subjects), (2) continuity (instead of binarity), (3) mechanisms (how), (4) conditions (for whom), and (5) cultural and social legitimacy (under what circumstances). Although affordance can also be applied to bicycles (e.g. electric assistance) and equipment (e.g. waterproof clothing) that extends cycling (Rérat 2021b), we focus here on infrastructure. We know discuss these five principles and the reasons why they are important in assessing the role of cycling infrastructure.

(1) *Cycling is relational and can be analyzed through the lens of affordance*. To afford connotes both provision and the ability to do something. Affordances are relational and lie between the features of the environment (cycling routes) and their users (current or potential cyclists). Viewing everyday cycling through the lens of affordances enables us to address how infrastructure shape action and how materiality and human agency operate together while avoiding determinism (i.e. a mechanical effect of infrastructure on cycling regardless of the context) (Davis, 2020; Davis and Chouinard, 2016).

(2) *Infrastructure afford to cycle in varying degrees*. The relationality of affordances highlights the fact that their effect is not binary but continuous; they afford in varying degrees (Evans et al., 2017) and in varying ways to different people (Heft, 2010). An environment or a route affords cycling to varying degrees according to its 'bikeability' or how cycling-friendly it is. As bikeability increases, everyday cycling can concern a larger population, cover longer distances and be more independent of weather conditions.

(3) *Cycling infrastructure afford cycling through various mechanisms*, where mechanisms refer to the *how* of human–artefact interactions. Infrastructure encourage or discourage cycling to a varying extent depending on their bikeability. Van Hagen and Govers (2019) classify environments according to a pyramid of customer needs. They identify three types of cycling contexts: "Dare-to-cycle" environments have poor infrastructure, lack continuity, are unsafe and are dominated by cars. Once safety is achieved, the infrastructure must be designed to allow cycling quickly and conveniently, creating an "able-to-cycle" environment. The challenge is then to provide an attractive and enjoyable environment that will invite more people to cycle more often and over longer distances: an "invited-to-cycle" environment. Van Hagen and Govers (ibid. p. 5) regard safety as a precondition

[1] A third one could be identified at the meso scale, i.e. the effects of cycling infrastructure on livability, retail businesses, car traffic, etc.

for cycling, speed and ease as dissatisfiers if they are not met, and comfort and experience as satisfiers. The bottom of the pyramid reflects functional qualities and the top hedonistic qualities.

(4) *Cycling routes require varying levels of dexterity*, and physical and cognitive skills (speed, positioning, etc.) vary from person to person (in terms of age, gender, frequency of cycling, etc.). A context's bikeability has an important effect on the number and diversity of cyclists. Geller identifies four categories of cyclists in the case of Portland, USA (Dill and McNeil, 2013; Pearson et al., 2024): the "strong and fearless" (very high cycling skills, very low need for infrastructure; less than 1 % of the population), the "enthused and confident" (high skills and motivations but need a certain level of bikeability; about 7 %), the "interested but concerned" (would cycle more if there were more safe infrastructure; 60 %) and the "no way, no how" (unwilling to cycle; 33 %).[2] Changing an environment from daring to inviting should allow to reach a higher cycling modal share, longer distances and a diversified public (van Hagen and Govers, 2019).

(5) *Road space is political*. As discussed above, infrastructure in place reflect the cultural and social legitimacy of transport modes and the power relations between them (Koglin and Rye, 2014). The higher the dominance of the car, the less space is given physically and symbolically to bikes, while the higher the bikeability of an environment, the more legitimate cycling is, because infrastructure assert cycling as a legitimate mode of transport.

2.3. Number of cyclists

Cross-sectional studies have found a positive relationship between the bikeability of an environment and the modal share of cycling (Buehler and Pucher, 2021), which may be partly explained by studies showing cyclists' safety concerns and preferences for separate lanes over sharing roads with motorized traffic (Buehler and Dill, 2016). It is therefore likely that appropriate infrastructure will encourage more cycling by providing the conditions that enable risk-averse people to take it up.

Indeed, the idea behind the adage, "Build it and they will come" assumes a latent demand for cycling that requires better infrastructure. In other words, some people are willing to cycle more – the "interested but concerned" and the "enthused and confident" according to Geller's typology (Dill and McNeil, 2013; Pearson et al., 2024) – but are deterred from doing so due to current routes (which are not safe, direct, enjoyable enough) and therefore opt for other modes of transport. This slogan applies to cycling the notion of induced traffic through the improvement of infrastructure (Goodwin, 1996); this has been supported by cross-sectional analyses (Crane et al., 2016). For example, Dill and Carr (2003) found that for every mile increase in the length of bike lanes, there was a 1 % increase in bicycle commuters in 43 US cities (Dill and Carr, 2003). Cervero et al. (2013), meanwhile, compared the evolution of cycling around train stations in San Francisco and found a clear effect of infrastructure on cycling modal share (Cervero, Caldwell, and Cuellar, 2013).

Critiques of cross-sectional studies point out the difficulty in addressing mechanisms (as these studies test association but not causality), confounders (the many interactive components at stake) and changes before and after an intervention (Krizek,Handy,and Forsyth, 2009; Crane et al., 2016; Heesch et al., 2016). They argue that there is still a lack of evidence on the effectiveness of infrastructure, as few studies use longitudinal data (Panter et al., 2016; Félix,Cambra,and Moura, 2020).

Several authors have called for (quasi) natural experiments. A strictly experimental study (or RCT, randomized controlled trial) would require the random assignment of a sample of participants either to a treatment or a control group, with behaviours measured before and after the intervention (Krizek,Handy,and Forsyth, 2009). This can easily be done in the case of soft measures (e.g. campaigns), but hard interventions (infrastructure) don't allow the random assignment of participants to treatment and control groups within the same area.

Several works have applied quasi-experimental designs and controlled for factors other than the intervention that may influence cycling. They used data from manual counts (Félix,Cambra,and Moura, 2020), automatic counters (Kraus and Koch, 2021; Büchel,Marra,and Corman, 2022; Fields et al., 2022) or apps such as Strava (Fosgerau et al., 2023),[3] comparing cycling traffic before and after interventions. They tried to control confounders by either choosing a relatively short time period, making comparisons with a similar route or area, or looking at people with the same exposition to the cycling intervention (e.g. people living within a specific radius) (Panter et al., 2016).

Most researchers have found that hard measures encourage cycling. For example, through manual counts in 45 locations, Félix et al. (2020) assessed the impacts of cycling infrastructure and bicycle sharing schemes in Lisbon, Portugal. They found a 3.5-fold increase in the number of cyclists after the expansion of the cycling network, and a further 2.5-fold increase with the implementation of bicycle sharing. In Minneapolis, USA, the number of cyclists increased by 69 % between 2007 and 2013 in locations with protected bike lanes (Fields et al., 2022), while in Glasgow, Scotland, four new infrastructures were assessed over 48 months using Strava data (Hong,McArthur,and Livingston, 2020). Three of them, all in the city centre and mainly segregated from motorized traffic, were already successful (+12 % to + 18 % monthly). Kraus and Koch (2021) measured cycling in 736 locations across 106 European cities and found that cycle lanes implemented after the first Covid-19 lockdown increased cycling between 11 % and 48 % between 2019 and 2020.

In assessing changes following an intervention, it is important to distinguish between new cycling traffic and traffic diverted from elsewhere (Goodman,Sahlqvist,and Ogilvie, 2013; Parker et al., 2013; Heesch et al., 2016). Fosgereau et al. (2023) did this by carrying out a simulation of the entire bicycle network in Copenhagen, Denmark, using GPS trajectories, and found that the network has led to an increase of 90 % in distance travelled (compared with a counterfactual without the bicycle network).

Quasi-experimental studies based on counting may overcome the challenges of obtaining longitudinal data and controlling confounders. However, they face several limits. For example, they are dependent on data being available via automatic counters and apps, and analyse flows without considering their content, the mechanisms through which infrastructure influences cycling, or who the cyclists being influenced are. The next section goes beyond the number of cyclists and addresses their characteristics and the journeys they make, while Section 2.5 looks at how they experience a route.

2.4. Characteristics of cyclists and their journeys

Route choice studies reveal a general preference for separation from motor traffic (Aldred and Dales, 2017) that is stronger among women and older people. More generally cyclists' gender and age inform about the risk and safety levels (Félix, Cambra, and Moura, 2020). A comparison across 17 countries (Goel et al., 2022) found that women are underrepresented in low-cycling contexts, and only start to make as

[2] Some cities aim to achieve AAA (all ages and abilities) or 8–80 (age range of people who should be able to cycle autonomously).

[3] Manual counts are cheap (at least for a limited time) and may collect additional data (cyclists' characteristics). Automatic counts are more costly but provide continuous data, although only on the number of cyclists. Apps provide precise data on journeys (through GPS tracking) and cyclist profiles, but are only used by a (specific) minority of cyclists, and their availability depends on third-party technology providers.

many cycle trips as men in places with a cycling modal share above 7 %. Older adults are usually underrepresented, but have relatively better representation where levels of cycling are high.

The wearing of high-visibility clothing and helmets by cyclists indicate that cycling is perceived as dangerous, while sporty clothing suggests that it requires much exertion or high speeds to keep up with motor traffic (Aldred and Dales, 2017). In London, UK, separate cycle routes show better – though still unequal – demographic balance among cyclists and a reduced tendency to wear helmets and sporty clothing (ibid.). Child seats, trailers, or cargo bikes, on the other hand, indicate that a route is seen as safe enough to carry children (Félix,Cambra,and Moura, 2020).

Few studies have addressed cyclists' characteristics through repeat observations (e.g. of apparent age and gender, and type of bike). In Brisbane, Australia, Heesch et al. (2016) found that a new cycling route induced some increase in cycling but was not enough to broaden the appeal of cycling to groups less likely to cycle. Similarly, a cohort study in the UK showed that awareness and use of new cycle lanes increased over time but with a dominance of recreational trips, and indicated that attracting less active individuals may require more time or larger infrastructure changes (Goodman,Sahlqvist,and Ogilvie, 2013).

2.5. Experience of cycling

A range of studies address cyclists' perceptions and experiences and conclude not only on the importance of good infrastructure – as positive experiences increase the likelihood that people will cycle – but also of taking into account users' expertise (Wesener et al., 2022). These studies capture subjective experiences while cycling or immediately afterwards through intercept surveys, off-site surveys, ride-along interviews, or video elicitation (a follow-up interview based on a recorded trip) (Kalra et al., 2023). Some studies use more technical methods, such as accelerometers, sound meters, or air quality meters (Calvey et al., 2015), or computer-based videos to measure passing distances (Götschi et al., 2018).

Understanding the quality of transport facilities goes back to the notion of Level of Service (LoS), which was developed in 1965 by the US Highway Capacity Manual. LoS measures the quality of motor traffic flow in terms of travel time and speed. However, unlike motorists, "whose objective is to minimize travel time while sitting in a heavily controlled indoor environment, cyclists interact with the open urban environment on which they have no control" (Barrero and Rodriguez-Valencia, 2022, 10). The bicycle level of service (BLoS) is therefore wider and requires adopting a cyclist's perspective, identifying (in) tangible elements that attract new cyclists and retain existing ones (ibid.), and considering cycling as a mobile engagement with landscape (Wesener et al., 2022).

Safety has received the most attention in research. The level of traffic stress (LTS) expresses how unsafe cyclists feel riding on a road segment, and is affected by the volume and speed of motor traffic and the level of separation from it (Bas et al., 2023). In addition to traffic safety, social safety – e.g. sense of isolation, lack of lighting, etc. – is also a deterrent for more cycling specifically among women (Xie and Spinney, 2018).

The Dutch Design manual for bicycle traffic (CROW, 2016) defines in addition to safety 4 criteria for cycling routes: directness, coherence (interconnection with other routes), comfort (minimal stops or nuisances), and attractiveness. These criteria can be re-ordered to match what was presented (2.2) as dare-to-cycle, able-to-cycle, and invited-to-cycle environments.

Existing research assesses users' perspectives at a specific time.[4] The lack of longitudinal data for assessing cyclists' experience is an important gap in the literature that we aim to fill with the analysis of the effects of a new cycle lane.

3. Research design

3.1. Case study

Fribourg, Switzerland, has 40,000 inhabitants and is predominantly French-speaking (85 % receive official documents in French, 15 % in German). The town stretches along both banks of the Sarine River and has an uneven topography.

In 2021, the cycling modal share in Fribourg accounted for approximately 4 %, vs 7.9 % of journeys nationally[5] (OFS and ARE 2023). In 2018, 82.5 % of Fribourg citizens voted for cycling to be included in the Swiss constitution (Rérat and Ravalet, 2022), which was 10 points above the national result (73.5 %). This may indicate that Fribourg residents want to "catch up" with the cycling practices of the rest of the country as cycling infrastructures are relatively undeveloped in Fribourg.

This paper assesses the effect of a new cycle lane stretching over 1.1 km on the *Boulevard de Pérolles*. The boulevard is indicative of the history of the politics of transport planning. The area of Pérolles was built over 80-meter-deep ravines during the industrialization of the city triggered by the arrival of the train. The boulevard was broad, and a tram line was opened in 1897. It was dismantled in 1965 and replaced by buses. The boulevard was already identified as a strategic route for cycling at the beginning of the 2000 s as it connects the train station and the city centre with parts of the University of Fribourg and the University of Applied Science (Fig. 1). It used to be regarded as dangerous for cycling, as people had to ride between parking spaces and moving motorized vehicles with a danger of dooring; the road had a speed limit of 50 km/h and 7800 to 9100 vehicles a day in 2018 according to the city's traffic counts. The boulevard was organized in the following way: on each side a walkway and car parking space on most of the length (1.9 m wide), a lane for all vehicles in the direction of the university (3.75 m), and a bus lane (3.25 m; open to cyclists but with up to 25 buses running per hour during the peak hours) and a car lane (3.25) towards the station.

No concrete project of cycling infrastructure had been studied until Spring 2020. After the first lockdown due to the Covid pandemic, a trial cycle lane was implemented as many other cities did around the world (Ortar and Rérat, 2024). This was in part to avoid a modal shift from public transport to cars following the reduced popularity of public transport under Covid-19. It was a temporary measure, and the municipality removed it after 60 days, according to normal procedure. However, as the trial had been successful, the municipality decided to go ahead with a permanent cycle lane on the boulevard. Some retailers, right-wing parties and car lobbies were strongly opposed, in part because 62 car parking spots had to be removed, but the courts ruled in favour of the project.

The intervention we studied consists of a cycle lane that is 1.1 km long (spanning the distance between two roundabouts) and 1.9 m wide (the width of the former car parking spaces), and goes from the train station towards the two universities (Fig. 2). The lane is continuous and cannot be used by cars, although there is no physical separation. The lane is interrupted three times for bus stops, however, where cyclists must wait behind the bus. In the other direction, there is no cycle lane, and cyclists must use the bus lane. The municipality has since this first intervention reduced the speed limit to 30 km/h and installed an

[4] One exception is Götschi et al. (2018), who analysed a left-turning bicycle box in high-density traffic. Their survey showed an improvement in perceived safety, although the median passing distance between bicycles and cars did not significantly change.

[5] The rest of the modal split in Fribourg is as follows: walking 41% of all journeys, cars and motorized two-wheelers 36%, and public transport 19% according to the Mobility and Transport Microcensus. This source is based on 55,000 interviews spread over a year. While it is nationally representative, there is a larger margin of error for smaller entities.

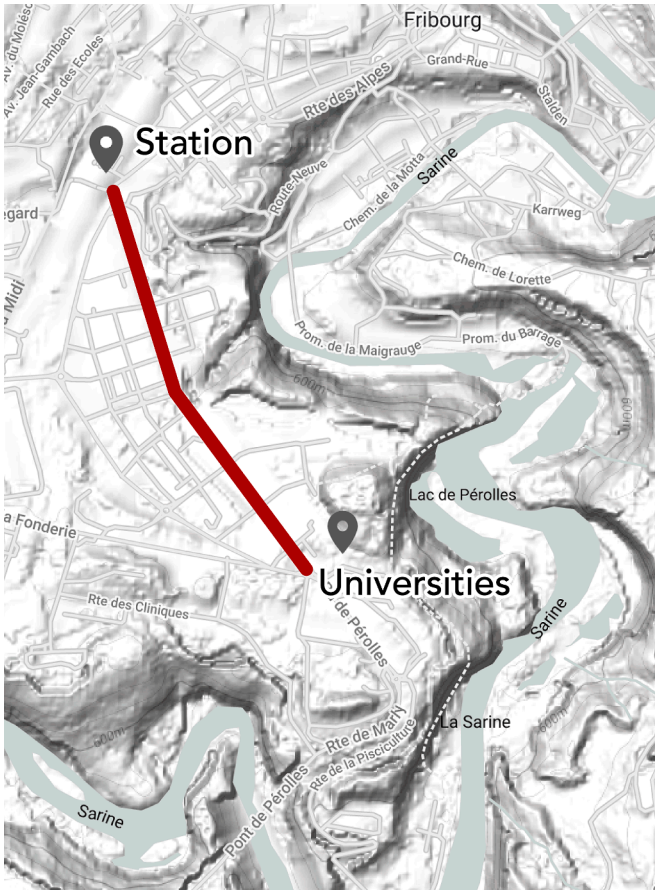

Fig. 1. Map of intervention area (created with snazzymaps.com).

Fig. 2. The new cycle lane on Boulevard de Pérolles.
Source: authors

automatic counter.

This intervention may not seem impressive: while it is better than nothing or than a cycle lane with a dashed line (that would allow cars to drive on it) and quite large, it is less ambitious than a cycle track (physically separated from motorized traffic) and concerns only one side of the road. Pérolles is nonetheless an interesting case study for several reasons: it is an ambitious measure in a low-cycling city where dedicated infrastructures are still rare; cycling competes with the various modes on that route (notably the frequent buses); it is well connected to the bicycle sharing scheme with three stations on the boulevard; and, finally, the boulevard is the main road artery in this area and there is only one alternative route with less traffic but it is less direct (*rue des Arsenaux*), due to the river valley in the east and the railways in the west (Fig. 1). An increase in cycling could therefore only very partly be explained by existing cyclists adopting a new route.

3.2. Methods

This paper assesses the effects of a new cycle lane in terms of the number of cyclists, their characteristics, and their experience. We used three methods: manual counting (no automatic counter was installed then), observation and intercept surveys (where we stopped cyclists to ask them a few questions). Data was collected before the implementation of the cycle lane, in September and October 2021, and then went back a year later. A one-year period avoids a habituation effect (respondents could become less positive with time (Skov-Petersen et al., 2017) and seasonal changes, and no confounder (e.g. another new major infrastructure) took place during that time. However, one year could be too short to identify some effects, as it takes time for some people to switch modes and take up cycling (Crane et al., 2016).

We chose three different days (Tuesday, Thursday, Saturday) from 7.30 am to 7.00 pm, in order to consider the temporality of cycling traffic (morning/evening peak hours, weekdays and weekends). For comparability issues, we were constrained by the start of the academic year (mid-September) and the autumn holiday (mid-October). We tried to have similar weather conditions between both years during this time frame; this worked for Tuesday and Thursday, but we could not avoid a quite rainy and unsettled Saturday in 2022 (Table 1). The comparison of the number of cyclists is therefore not reliable on Saturday, not least because cycling is more dependent on the weather on that day as it is much less related to commuting and more to optional activities (leisure, sport, shopping). The number of intercept surveys accounts for 473 in 2021 and 350 in 2022; this lower number is explained by the weather on Saturday.[6]

Table 1
Days of observation.

	2021		2022	
	Date	Weather	Date	Weather
Tuesday	September 28	Cloudy, 18 °C	October 11	Sunny, 12 °C
Thursday	October 7	Partly cloudy, 10 °C	September 22	Sunny, 11 °C
Saturday	September 25	Sunny, 23 °C	October 15	Unsettled, 16 °C

[6] Moreover, as recreational cycling is more seasonal than utility cycling, broader weather conditions could have played a role too. The very wet summer of 2021 was followed by a warm, sunny autumn, which may have encouraged people to extend their recreative cycling, meaning that we saw more cyclists on Saturdays in September 2021. In contrast, 2022 saw a wet and cold autumn after a hot and sunny summer, so this may have contributed to the reduced number of cyclists on Saturdays in October 2022.

Five trained research assistants were in the field. Two of them counted and observed cyclists (type of bike, apparent gender and age) for half-hourly periods in both directions, while the other three conducted the intercept surveys with as many cyclists as possible travelling in the direction of the universities. A large sign announced the survey, and interviewers wore high-visibility jackets. As there is no alternative route, people going to the city centre or the train station were likely to be interviewed on their way back.

Intercept surveys lasted 4–5 min and addressed three categories of data: (1) cyclists' characteristics (type of bike, age, and gender[7]), (2) their use of the boulevard (reason for travel, journey length, frequency, origin, destination, etc.) and (3) their experience of cycling in Fribourg and on the boulevard. Questions on experience refer to the CROW criteria (see above) – directness, coherence, safety, comfort, and attractiveness – that we reorganized into three dimensions: efficiency (including directness and coherence), safety, and comfort (including attractiveness). They were asked in the same way both in 2021 and 2022 to assess the effects of the cycle lane.

We first used four statements ("the journey is direct or quick", "you feel safe", "the cohabitation with buses and cars goes well" and "the journey is pleasant/enjoyable") and cyclists had to rate their agreement on a Likert-scale (totally disagree, somewhat disagree, somewhat agree, totally agree).

We also asked the following open question: "Give three adjectives to describe your experience when cycling on the boulevard (in the outward direction)".[8] Adjectives were coded into four categories – efficiency, safety, comfort as well as global assessment (ie. general evaluation of the route) – and as being positive, neutral, or negative. Through this approach, we were able to collect more spontaneous answers to address the experience on the boulevard. A typology of cyclists was created based on the number of negative adjectives: dissatisfied (three negative adjectives); concerned (two), confident (one) and enthusiastic (none).

This project provided an opportunity to test an approach combining counting, observations, and intercept surveys. We will reflect on the benefits and challenges of this approach in the conclusion.

4. Results

4.1. Cycling traffic

In 2021 we counted 1766 cyclists on Tuesday and 1517 on Thursday, which is twice as much as on Saturday (819 . Traffic varies greatly during weekdays, with peak hours at 7.30–8.30 and 17.00–18.30, but there is very little variation in traffic across the day on Saturdays. There are also more cyclists heading towards the universities in the morning and towards the station in the evening. These results give a first hint of the commuting use of the route.

A first effect of the cycle lane is a strong increase in cycling traffic over one year. A comparison of results from Tuesday (+293; +21 %) and Thursday (+364; 19 %) reveals a similarity that corroborates this increase.

On Saturdays, a decrease in number of cyclists (−14 %) is likely due to a combination of bad weather in 2022 and the higher proportion of optional journeys on that day (much less commuting and more leisure, sport and shopping).

4.2. Characteristics of cyclists and their practice

Characteristics of cyclists refer to gender, age and type of bike.[9] Men are slightly overrepresented (Table 2). This gap is however lower that what is usually observed in low-cycling cities (Goel et al., 2022). There are very few people aged below 18[10] or over 65. These age groups are also commonly underrepresented in low-cycling cities. It is nonetheless worth noting that the imbalance of the age structure is accentuated here due to the proximity of the university and train station (attracting working-age groups and young adults) and the absence of other schools.

The share of 18–24-year-olds (about 20 %) may seem normal given the proximity of universities. Yet this does not seem to be representative of the rest of Switzerland: nationally, people aged 18–24 have the lowest cycling modal share other than people over 80 (4 %; similar to the 75–79 age group) (OFS and ARE 2023), and even a survey in another Swiss university found that people aged less than 24 cycle less than people aged 25–50 even when location and distance are taken into account (Rérat 2021a).

The cycle lane did not fundamentally change the age and gender structure although there is a little increase in the youngest and middle-aged cyclists. The increase in the number of men indicated by the intercept survey was not confirmed by our observations. As we will discuss further, the lack of effect of the cycle lane on gender structure may be due to low bikeability of the rest of the town and to the fact that more time may be needed to attract new cyclists and to put in place new

Table 2
Characteristics of cyclists.

		2021	2022	Change (points of %)
Gender (intercept survey/ observation)	**Men**	53.5 %/57.4 %	56.6 %/57.9 %	+3.1/ +0.5
	Women	44.6 %/42.1 %	42.3 %/41.8 %	−2.3/-0.3
	Other/don't know	1.8 %/0.5 %	1.1 %/0.3 %	−0.7/-0.2
Age (intercept survey)	**Less than 18**	1.8 %	3.2 %	+1.4
	18–24	21.6 %	18.3 %	−3.3
	25–39	32.6 %	33.8 %	+1.2
	40–54	21.3 %	25.8 %	+4.5
	55–64	16.7 %	13.2 %	−3.5
	65 and more	6 %	5.7 %	−0.3
	Missing	0.2 %	0.3 %	+0.1
Type of bike (observation)	**Conventional**	62.6 %	55 %	−7.6
	E-bike (25 km/ h)	20.4 %	22.5 %	+2.1
	E-Bike (45 km/ h)[1][10]	7 %	7.5 %	+0.5
	Cargo bike/ trailer/child seat	4 %	4.2 %	+0.2
	Bicycle sharing	5.6 %	9.8 %	+4.2
	Other	0.4 %	1 %	+0.6

[1]E-bikes offering assistance up to 45 km/h have a number plate, making it easy to identify them.

[7] The number of questions in an intercept survey is limited due to time constraints, and we decided not to address socio-economic status, as a proportion of the cyclists were likely to be students with a high level of education but little to no income.

[8] Such a question was previously used by Munafò et al. (2015) to address the images of transport modes and the predisposition to use them.

[9] Characteristics of cyclists were recorded through observations and intercept surveys. Intercept surveys only include cyclists who accepted to stop. Observations provide comprehensive data on the type of bike but are less precise regarding gender and age as they are based on appearance and the evaluation of research assistants (age was roughly estimated: less than 18, 18–65, above 65). We have kept both data for gender. The slight difference shown by the intercept surveys in 2022 can be explained by the fact that more males stopped rather than a change in the gender structure.

[10] Children in cargo bikes, trailers or back seat were not counted.

habits.

The observations give an overview of the kind of bike used. Conventional bicycles are in the majority (more than 60 % in 2021), but their share is declining (−7.6 points by 2022) in favour of e-bikes, reflecting the growing popularity of the latter in Switzerland (Marincek and Rérat, 2022). Cargo bikes or bikes with a trailer/child seat still represent a small share (one in 20) but highlight the potential of bikes for care mobility (i.e. activities carried out for the care of children, the maintenance of the home such as shopping, etc.).

The most important change is the increase in bicycle sharing from 5.6 % to 9.8 %. This trend suggests a more spontaneous and occasional use made possible by greater safety (see below).

We now address cycling practices (Table 3). The first goal of our questions in the intercept surveys was to gain a better understanding of how the boulevard is used. Due to the lower number of cyclists on Saturday in 2022, a comparison between the years requires caution.

Three-quarters of cyclists ride on the boulevard almost daily, while an additional fifth use it once or twice a week. These two proportions increased slightly between 2021 and 2022 (+1.2 point and + 1 respectively), indicating that the cycle lane may have led to a more frequent use.

Cycling is mainly utilitarian: about 90 % of respondents cycle to get to an activity – mainly their place of work/study – and 10 % as a sport or leisure activity in itself. Commuting is much more common on weekdays (more than 75 % of journeys) than on Saturday (less than 30 %), while the opposite is found for travelling to other activities and cycling for sport/leisure (50 % and 20 % respectively on Saturday). With the cycle lane, the share of commuting trips increased, and other activities decreased, while cycling as a sport or leisure activity stayed stable.

In terms of journey length, almost 80 % of journeys last less than 20 min. Between 2021 and 2022, there was a 4-point increase in journeys lasting less than 10 min and between 20 and 30 min (while there was a decrease in the number of journeys lasting 10–20 and over 30 min).[11]

The origin and destination of trips were also addressed: 13 % of the journeys in 2022 started at the station, indicating the importance of intermodality (combination of cycling and train), and 14 % from the Pérolles area. More than half come from other areas in Fribourg (54 %, of which 18 % from the city centre) and 20 % from another municipality. Pérolles is the most frequent destination (63 %), followed by the rest of the city (13 %) and neighbouring municipalities (25 %). Compared to 2021, an increased popularity of Pérolles as a destination (+3) and distant neighbourhoods as places of origin (+2) has been noted.

Displacement of cyclists from other roads contributes to the growth of cycling traffic but seems minor. Only 6.8 % in 2022 strongly agree – and a similar share slightly agree – with the statement that they changed their route to include the new cycle lane.[12]

The boulevard is not only a way of getting from one place to another: 31.5 % often stop in local shops, and 45.7 % do so sometimes. These shares increased (+0.4 and + 2.4) with the cycle lane, suggesting that stopping is now easier.

4.3. Experience of cycling

In 2021, almost all cyclists found the journey on the boulevard to be direct or fast (93.5 % somewhat or totally agree) (Table 4). Two-thirds said that it was enjoyable (64.8 %), but only a small majority that it was safe (51.1 %) and that sharing the road with buses and cars was going well (53.1 %). A small half of cyclists was therefore critical of the cycle lane, citing proximity with motorized vehicles and the danger of dooring.

The cycle lane has clear effects. Positive opinion related to directness increased and almost all cyclists (97 %) somewhat or totally agree that the journey is direct or fast, with a 10-point increase in those saying that they totally agree. More people find the journey enjoyable in 2022, with the most frequent answer being “totally agree” (+22.6 compared to 2021). Users’ perception of safety also improved: in 2022, more than half somewhat agree with the statement that they feel safe on the boulevard (+17.3), and more than a quarter totally agree (+13.4). Sharing the road with buses and cars is also much better rated.

Thus, it is clear that the cycle lane has considerably improved cyclists’ experience. However, an important minority is still critical about

Table 3
Characteristics of cycling practice (intercept surveys).

		2021	2022	Change (points of percentage)
Frequency of cycling on the boulevard	**Nearly every day**	73.7 %	74.9 %	+1.2
	One to two times a week	16.4 %	17.4 %	+1
	A few times a month	3.9 %	3.6 %	−0.3
	Less often	6 %	4.2 %	−1.8
Reason for the journey	**Work/study**	59.2 %	69.5 %	+10.3
	To get to an activity (shopping, visits, etc.)	31.3 %	20.5 %	−10.8
	Sport or leisure ride	9.4 %	10.1 %	+0.7
Duration of the journey	**Less than 10 min**	26.5 %	30.9 %	+4.4
	10–20 min	51.9 %	48.1 %	−3.8
	20–30 min	9.6 %	14 %	+4.4
	More than 30 min	11.9 %	6.9 %	−5

Table 4
Experience of cyclists on the boulevard.

When you are cycling on the boulevard…		Totally disagree	Somewhat disagree	Somewhat agree	Totally agree
The journey is direct or fast	**2021**	1.1 %	5.4 %	31 %	62.5 %
	2022	0.6 %	2.6 %	24.5 %	72.3 %
	Change	−0.6	−2.8	−6.5	**+9.8**
The journey is enjoyable	**2021**	6.1 %	29.1 %	41.3 %	23.5 %
	2022	3.2 %	11.2 %	39.5 %	46.1 %
	Change	−2.9	−16.8	−1.8	**+22.6**
You feel safe	**2021**	12.6 %	36.4 %	37.3 %	13.8 %
	2022	4.6 %	13.6 %	54.6 %	27.2 %
	Change	−8	−22.8	**+17.3**	**+13.4**
Sharing the road with buses and cars is going well	**2021**	10.7 %	36.1 %	42.9 %	10.3 %
	2022	4.3 %	24.5 %	50.4 %	20.8 %
	Change	−6.4	−11.6	**+7.5**	**+10.4**

[11] One possible explanation is that journeys have become more efficient (or perceived as such) with the cycle lane. Journeys that previously took 10–20 minutes could now take 10, and those that used to take over 30 minutes could now take 20–30 minutes.

[12] Only counters on the boulevard and on the possible alternative routes could give a precise answer though.

safety (18.2 %) as they have to ride close to motorized modes (28.8 %), as the painted lines do not provide physical separation, and as they have to cross three bus stops.

Women are more critical than men regarding directness (4.8 % had a negative opinion in 2022 vs 2 % of men), attractiveness (19.6 % vs 10.6 %), safety (21.6 % vs 15.6 %) and cohabitation with motorized traffic (34.5 % vs 24.7 %).[13] At the same time, women seem to have benefited most from the new cycle lane: the percentage of women who were critical of safety decreased from 54.4 % to 21.6 % (–32.8; for men, respectively 44.5 %, 15.6 %, −28.9 points).

Coding the adjectives given by cyclists (Table 5) showed that positive adjectives increased from 46 % to 72 %, which highlights a clear improvement in the cycling experience. Negative words referring to safety – such as 'dangerous', '(being) attentive' and 'stressful' – decreased from 34 % to 15 %. Thus safety (or lack of it) is much less of an issue than before. Nonetheless, negative adjectives referring to safety have not been replaced by positive ones (from 7 % to 8 % of the total). For many cyclists, the positives regarding safety are now taken for granted as basic requirements or preconditions, and positive adjectives are given to other aspects. Positive terms regarding efficiency, such as 'fast', 'practical', 'fluid', 'direct' and 'flat' increased from 18 % to 26 %. The same trend was observed for comfort (from 15 % to 19 %), with words like 'enjoyable', 'quiet' and 'calm', although the word 'chaotic' also appeared more often. With the cycle lane, a fifth of the adjectives described the positive evolution in broad terms ('improved', 'positive', 'good', 'better').

We categorized respondents according to the adjectives they gave (Table 6): dissatisfied (three negative adjectives); concerned (two negative adjectives, one of which related to safety), confident (one negative) and enthusiastic (no negative adjectives). The percentage of dissatisfied cyclists declined sharply (–22 points) in favour of confident (+4) and enthusiastic (+21), the latter group now making up half of all respondents.

These results reinforce the interpretation of a clear improvement but not yet an ideal situation. However, the most problematic aspects are found in the rest of the city. Half of the respondents are not satisfied with the cycling amenities in Fribourg, although they slightly declined from 53.4 % in 2021 to 49.7 % in 2022 (45 % among men, 56 % among women). Yet the proportion of respondents who disagree that cyclists' needs are considered went from 44.9 % to 48.7 %, which could be explained by some cyclists becoming more critical with the lack of infrastructures.

5. Conclusion

As cycling has many advantages in terms of ecological footprint, space consumption and public health, it is important to make this practice safe, efficient and attractive to a large number. To do so, it is crucial to assess current cycling infrastructure and the effects of new ones. We studied the effects of a new 1.1 km cycle lane in Fribourg, Switzerland, through the theoretical concept of affordance (Davis, 2020) that we applied to cycling.

This framework provides a lens through which to address the effect of a new cycling infrastructure by focusing on the degree to which it "affords" cycling, how it does so, for whom and in what circumstances. In other words, it is a way to critically assess the slogan "Build it and they will come" not only by measuring the evolution of the number of cyclists, but also by considering the (objective and subjective) characteristics of an infrastructure ("it"), identifying its effects on the experience of cycling (why "they come") and distinguishing various types of cyclists ("they").

Methodologically, counting is the most common tool in research but is far from sufficient. Our approach combined counting with observation and intercept surveys in order to obtain data on cyclists' characteristics, journeys and experiences. As the users' perspective is at the core of our paper, we asked not only closed questions but also an open question to generate spontaneous adjectives that evaluate the route in terms of safety, efficiency, and attractiveness. Furthermore, since we needed longitudinal data to fully assess the effects of the cycle lane, we conducted two fieldwork studies before and after the cycle lane was introduced.

This approach provides important data on cycling and on the effects of an intervention. It could be applied elsewhere, including by cycling advocacy groups or professionals, perhaps using automatic counters in place of manual counting to cover a longer period of time. The interval of one year seems appropriate to minimize the impacts of seasonality (climate, academic year, holidays, etc.), and to give time for people to adopt the infrastructure without becoming too accustomed to it and forgetting the previous situation. Observations consider all cyclists and not only the ones who stop for the intercept surveys but add less value than the other methods.

Empirically, the growth in the number of cyclists (+20 % during the week) supports the "build it and they will come" argument (e.g. Cervero, Caldwell,and Cuellar, 2013). There is no data in the town of Fribourg to compare with. However, out of 188 automatic counters located in urban regions in Switzerland, 161 (86 %) recorded a smaller growth rate than 20 % between 2021 and 2022 (Schmassmann and Rérat, 2022). Other research also found an effect of infrastructure change on cycling traffic (Félix,Cambra,and Moura, 2020; Hong,McArthur,and Livingston, 2020; Fields et al., 2022). Although methods, time and context differ, the evolution in Fribourg is rather higher than average. This may be due to some favourable conditions in place (a route between a station and a university campus, bicycle sharing schemes, etc.). However, it must be noted that bikes are in competition on this route, most notably with an efficient bus service, and that the reorientation of cyclist flows has been very limited. Cycling traffic induced by the new infrastructure highlights the latent demand that exists in contexts such as Swiss cities, which is also indicated by local and national votes (Rérat and Ravalet, 2022).

The main improvement brought about by the new cycle lane is safety, confirming the importance of separating cycling from motorized traffic (Bas et al., 2023) although the cycle lane in Fribourg does not meet high-quality standards as it does not provide physical separation from motorized traffic. Cyclists' feeling of safety increased from 51 % to 82 %, and positive views on the cohabitation with buses and cars from 53 % to 71 %. More interviewees also regard the journeys as being faster and more enjoyable than before. Easier cycling conditions also explain why bicycle sharing (and therefore more occasional and spontaneous uses) doubled. Thus the boulevard went from a "dare-to-cycle" environment to an "able-to-cycle" environment (van Hagen and Govers, 2019). The adjectives given by interviewees to assess their experience confirm that safety is a precondition (ibid.): it is often quoted when insufficient but with the implementation of the cycle lane discourses shifted to other dimensions such as efficiency and attractiveness.

Our results show the importance of safety not only to attract new cyclists but also to maintain or reinforce existing practices. It is therefore important to consider the whole diversity of cyclists and not simply to see them as a homogeneous group that has adopted a practice once and for all or to assume that they are all fully satisfied with the amenities provided and don't face any difficulties (Dill and McNeil, 2013; Pearson et al., 2024). Rather, since people who regularly feel unsafe are likely to have a more fragile cycling practice, these may be the first group to target in order to increase and sustain cycling.

Moreover, a strong minority finds that the cycle lane is not safe, and women and both young and elderly people continue to be underrepresented. While cross-sectorial studies show an increase in these population groups as safety is improved (e.g. Goel et al., 2022), several potential reasons can be put forward to explain why this is not (yet) the case here. First, attracting a wider range of individuals may require

[13] The number of young and older cyclists was too small to carry out this analysis.

Table 5
Categories of adjectives assessing the experience on the boulevard.

	2021 (n = 1047)			2022 (n = 944)		
	Positive	Neutral	Negative	Positive	Neutral	Negative
Safety	7 %	–	34 %	8 %	–	15 %
Efficiency	18 %	–	4 %	26 %	–	1 %
Comfort	15 %	–	11 %	19 %	–	9 %
Global assessment	6 %	2 %	2 %	19 %	2 %	1 %
Total	46 %	2 %	51 %	72 %	2 %	26 %

Table 6
Typology of cyclists according to the adjectives assessing their experience on the boulevard.

	2021 (n = 422)	2022 (n = 334)	Evolution
Dissatisfied	31 %	9 %	−22
Concerned	28 %	26 %	−2
Confident	12 %	16 %	+4
Enthusiastic	29 %	50 %	+21
Total	100 %	100 %	–

larger infrastructure changes (e.g. physically separating motor traffic and bikes) or more time (e.g. the improvement in perceived safety was higher among women, which could influence the gender split in the longer term). Second, the proximity of the station and universities explains the overrepresentation of working-age adults. Third, the main limiting factor is now outside the cycle lane: 45 % of men and 56 % of women are not satisfied with cycling amenities in the rest of Fribourg. Given that current cyclists are likely to be much more motivated and skilled than potential cyclists, "soft" measures (promotional campaigns, cycling classes, etc.) are necessary to help develop cycling, but are not likely to develop cycling to a significant extent as they don't address these safety issues.

Additional effects of the bike lane are implicit. Its implementation on the main road of Fribourg is symbolically and politically important in a car-dominated context, helping to legitimize cycling; the lane's success also makes future projects more likely. Furthermore, since people aged 18–24 have the lowest cycling modal share in Switzerland among age groups (except for people above 80), providing quality infrastructure close to university campuses could lead to a learning effect during this critical period of young adults' lives that could last into later life (Rérat 2021a).

There are several limitations to this research. It addressed a small-scale study, there were no control areas, other dimensions could have been addressed (landscape, ambiance, etc.) and the data does not tell us the extent to which the increase is due to new users or to an extended cycling practice. Additional longitudinal and comparative research would allow more general results. Our approach nonetheless shows the importance of complementing counting with an analysis of cyclists' perceptions and experiences, and making use of their expertise in order to design infrastructure (Wesener et al., 2022).

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CRediT authorship contribution statement

Patrick Rérat: Conceptualization, Funding acquisition, Project administration, Writing – original draft. **Aurélie Schmassmann:** Data curation, Formal analysis, Investigation, Methodology, Writing – review & editing.

Declaration of competing interest

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.

Data availability

The data that has been used is confidential.

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