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Bahrami, Farzaneh; Rigal, Alexandre

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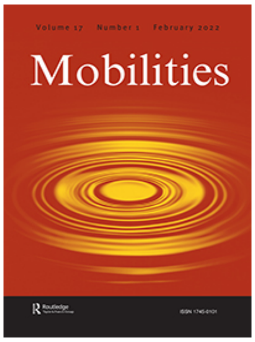

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Planning for plurality of streets: a spheric approach to micromobilities

Farzaneh Bahrami [a] and Alexandre Rigal [b]

[a]Faculty of Spatial Sciences, University of Groningen, Groningen, Netherlands; [b]School of Architecture, Civil and Environmental Engineering (ENAC), Ecole Polytechnique Fédérale de Lausanne, Laboratoire de Sociologie Urbaine (Lasur), Lausanne, Switzerland

ABSTRACT
Micromobilities have proliferated over recent years, enabled by technological advances. Together they present opportunities to flip urban mobility into a new system, beyond car dominance, towards inclusivity, diversity, and sustainability. We propose a theoretical framework to compare these vehicles and assess their potential in urban space. The notion of *Sphere* and the conceptions associated with it guide the development of our framework, enabling classification and analysis of micromobilities evaluating their impacts on their immediate environment and their capacities to cohabit with other modes of transport. The discursive analysis of 53 interviewees is used to corroborate our framework, particularly investigating the spheric characteristics of mobility experiences using various modes in diverse urban settings in Switzerland. This paper first adopts a historical perspective, exploring the emergence of vehicular innovations that developed in response to the early problems faced by the car system in cities and traces the evolution of these innovations through to the recent proliferation of micromobilities. Then the framework and interviews are described. Finally, we discuss the socio-spatial implications of the classification of transport modes based on their spheric properties, with a view to enabling new perspectives and potentially new socio-spatial relations towards the plurality of streets.

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Micromobility; spheres; car system; transition; cycling; walking

1. Introduction

> Today, those in despair at the war between automobiles and cities, are apt to depict the impasse as a war between automobiles and pedestrians . . . To think of city traffic problems in oversimplified terms of pedestrians vs. car, and to fix on the segregation of each as a principal goal is to go to the problem from the wrong end.
>
> (Jacobs 1961, 344)

Cars and pedestrians are often portrayed as unbalanced competitors for the urban space (Schneider 1971; Breines and Dean 1974), a dichotomy where the comfort, speed, and privacy of cars (Sheller and Urry 2000; Urry 2004, 2006) are contrasted with the effort, slowness, and sociability of walking (Demerath and Levinger 2003; te Brömmelstroet et al. 2017). In between, there has been bicycle (Horton, Rosen, and Cox 2016), and recently, a multitude of various other modes emerges (microcars, cyclecars, electric and cargo bikes, e-scooters, solowheels, etc.), each of which currently holds a small share of the modal split in cities. Together, however, these vehicles, including bicycle, are disrupting the urban landscape and displacing the categories of transport planning. How can

CONTACT Alexandre Rigal alexandre.rigal@epfl.ch

micromobilities' hype be seized upon and transformed into a sustainable change in mobility system? We argue that an encompassing framework is urgently needed to identify their characteristics, to enable their recognition in urban discourses and to promote their integration within mobility schemes.

The term micromobilities has been recently employed to refer to lightweight, swift-paced micro-vehicles that stand between pedestrian and car (McQueen et al. 2020; Oeschger, Paraic, and Caulfield 2020; Fitt and Curl 2020; Reck et al. 2021; Christoforou et al. 2021). However, micromobilities are not a recent invention. Historical attempts to replace cars with microbilities have failed and it is crucial to understand why. Since at least the 1960s, with the conviction that 'people will use automobiles as long as nothing better is available' (Gruen 1964) and the hope that 'we are not at the end of our ingenuity for that matter' (Buchanan 1963), numerous vehicular innovations were proposed to rectify the socio-spatial problems of the private car (e.g. Richards 1966). With the emergence of the early critiques of cars in cities (Jacobs 1961; Mumford 1963), the attempts to solve motorization problems – besides spatial strategies – also called for the development of innovative alternative vehicles. Introducing intra-city solutions, proposals ranged from very basic and practical ideas, e.g. the use of battery-operated electric scooters, to automatic people movers, and private or shared mini-cars (Scarinci, Bahrami, and Bierlaire 2017). However, these innovations remained as curious proposals, or were only used by specific groups: disabled and older people (May, Garrett, and Ballantyne 2010), teenagers and the adventurous in the city (e.g. Platt 2018).

In the absence of a proper recognition within urban discourses and a thorough research agenda, micromobilities risk remaining as ludic objects or as replacements for short trips otherwise taken by public transport or by walking. A challenging aspect that hinders federating discourses and policies for the integration of these vehicles into the urban mobility schemes stems from their variety: the differences in their physical characteristics, space requirements, speeds, and modes of interaction. Hence, without a unifying framework, they remain scattered, insignificant transport means, whether it be a scooter, a cargo bike, or recent attempts from the car industry to reinvent personal mobility. A theoretical framework is needed to render these vehicles comparable, and to enable an assessment of their impact on urban space and their capacities.

Micromobilities can potentially flip urban mobility into a new system, beyond car dominance and its spatial patterns of segregation and fragmentation (Dennis and Urry 2013). Recent estimates based on US data, identify that single trips on bikes and scooters in sharing systems grew from 320,000 to 136 million[1] between 2010 and 2019. Further, in 2019, the global micromobility market's revenue was estimated to be 2.5 billion US dollars.[2] The indicators of this potential new system are also societal. The changes towards more urban lifestyles (Kaufmann and Ravalet 2016) and the rise of both one-child families[3] and one-person households[4] reinforce the individual nature of mobilities.

The light-weight characteristics and low-energy consumption of micromobilities, presenting a combination of human effort and simple mechanical energy or light motorization, make them more efficient and socially inclusive than cars (Illich 1974). Micromobilities variously contribute to the ecological transition (de Bortoli and Christoforou 2021), and to more sustainable mobilities (Paterson 2000). We propose to analyse the spatial and social impacts of micromobilities in cities, using the notion of the sphere (Sloterdijk 2004, 2011, 2014), and thus transforming usual metaphors depicting vehicles (e.g. car as a cocoon) into analytical tools.

In the remainder of this paper, we first adopt a historical perspective, exploring the emergence of vehicular innovations that developed in response to the early problems faced by the car system in cities and trace the evolution of these innovations to the recent proliferation of micromobilities. Further, we make use of the notion of the *sphere*, as developed by Peter Sloterdijk (2011, 2014, 2004), to establish a set of vehicle properties. Leveraging on reflections and concepts surrounding the notion of the sphere, we propose a classification and analysis of the emerging micro-vehicles, allowing for the evaluation of their impact on their immediate environment, and their capacity to cohabitate with other modes in the urban space. Drawing on the results of a set of semi-structured interviews on daily mobility practices and aspirations of inhabitants in Switzerland, we explore spheric characteristics of mobility experiences. Finally, we discuss the socio-spatial implications of the classification of transport modes based on their spheric properties, enabling new perspectives and potentially new socio-spatial relations towards the plurality of streets and redistribution of street space for a more sustainable mobility.

2. Micromobilities

2.1. Background, the context of the emergence

The impossibility of sustaining automobility has been argued since at least the second half of the twentieth century where different aspects have been discussed that go beyond environmental issues and the emphasise on the socio-spatial impacts of cars (Jacobs 1961; Mumford 1963; Kenworthy and Newman 1989; Böhm et al. 2006). The acknowledged limits of the car system launched an engaged effort in developing innovative solutions for efficient and opportunistic uses of cities' spaces.

The previously discussed attempts to rethink the spatial constraints of the motor car consisted of playing with the form, size, and imprint of the car and led to a multitude of proposed prototypes and inventions. One of these was the introduction of microcars for city uses. They were initially proposed as hybrids between motorcycles and cars, providing better weather protection and efficiency in terms of space and energy consumption. For example, in 1942, *Œuf électrique* (The electric egg), an early prototype of microcars, was presented as a clean and practical device for Paris, which by taking half the space of a normal car, would allow doubling the parking spaces in Paris.[5] In the 1960s, a decade marked by the presence and prevalence of the theme of 'future' in urban projects, new mobility solutions constituted an essential part of the architects' and urbanists' visions for cities (Rouillard 2009). Brian Richards, for example, a British architect and a member of CIAM (International Congresses of Modern Architecture), published several widely influential books on reinventing mobility in cities (Richards 1966, 1976, 1990). His solutions ranged from very basic and practical ideas, e.g. the use of battery-operated electric scooters, to various microcars, automatic people movers, and travelators. He widely discussed their relevance and potential for rethinking city life. In this period, *New Movement in Cities* (Richards 1966) was established as a fundamental architecture and urban design text, fitting with the visionary projects of other leading architectural groups of the time, e.g. Archigram.[6] The search for alternatives to private cars was also extended to proposals for new patterns of use. The Witkar (White Car), which was a two-seater car with space for a child and packages, was launched in Amsterdam in 1974. It was proposed as a car-sharing system by Luud Schimmelpennink, who had introduced the principle of shared bicycles in cities (Richards 1976). The Witkar system operated between 1974 and 1986 but the project remained in its limited scope of the demonstration phase.

Reinventing mobilities with a focus on micro-vehicles was often restricted to the small perimeters of city centres, pedestrian precincts, malls, theme parks, and campuses. The considerations for human scale in cities in this period acknowledged 'the right of the individual over the tyranny of mechanical tools' (Congrès Internationaux d'Architecture Moderne (CIAM) VIII Rogers, et al., 1952), but remained limited in its concentration specifically on the 'heart of the city.[7]' While 'the heart of our cities' (Gruen 1964) was rediscovered as a social territory, the car infrastructure continued to develop around small islands of public spaces. Overall, design proposals for micro-vehicles in this period lacked large-scale visions. In the following years and with the 'interruption of the theme of future' in urban projects,[8] micro-vehicles disappeared nearly completely from architectural books and urban reflections. The introduction of modal shift strategies within the sustainable transport paradigm shifted the focus of the discussion from vehicular innovations to changing patterns of use and travel behaviour (Whitelegg 1994; Apel and Pharoah 1995). These strategies aimed at encouraging car alternatives by fostering the revival of public transport and the reconsideration of walking and cycling.

Among the vast gradient of micromobilities (between cars and pedestrians) that had been introduced, only bicycle re-emerged successfully as a means of transport (Héran 2015; Carstensen and Ebert 2012). Even if marginally, bicycles started to be integrated into urban transport schemes (e.g. Ploeger 1997), thus by now having been established as one of the four main categories often cited within the urban transport literature: public transport, car, bicycle, and pedestrian. These four categories constitute the main categories also within design approaches known as 'complete street' that aim to propose an inclusive design for *all* modes and every user of the street (McCann 2013). The use of the bicycle that had experienced a drastic drop between the 1950s and 1970s in many European cities (De la Bruhèze and Veraart 1999), had a resurgence through by a collective will expressed by protests (Okraszewska 2014) and critical masses (Furness 2007) as well as through support from political and professional initiatives (Huré and Passalacqua 2017).

2.2. The recent proliferation of micromobilities

Small and light vehicles increasingly proliferate and open their space in cities both by individual practices and through public programmes. Early public free-floating scooters were seen as oddities as recent as a few years ago. For example, *Baillargues*, a small town near Montpellier in Southern France, was discussed in the French national news in 2017 for an eccentric decision of its mayor to combine sharing scooters with TER trains.[9] However, free-floating sharing schemes of e-scooters have since consistently increased in capacity and reach in many cities around the world so that by August 2018, 90 cities had a system of free-floating e-scooters (Christoforou et al. 2021). The broad category of small personal vehicles, i.e. electric rideable personal mobility devices, shares some characteristics in terms of speed and road requirements with bicycles and electric bicycles. The rise in their popularity coincides with an increase in the use and sale of both e-bicycles and cargo bikes. The numbers suggest that 3.7 million e-bikes were sold in 2019 only in the European Union and in France, the sales of e-scooters surpassed that of electric bicycles in late 2018.[10] Further, the cargo bike industry expected growth of its market of over 50%.[11] In response to these recent developments of rapid growth, Switzerland's Federal Office of Statistics, dedicated a separate category to e-bikes for the first time in 2015, thus distinguishing it from traditional bicycles within their household vehicle ownership statistics. The outbreak of the Coronavirus has additionally accelerated the cycling surge.[12] For example, in a recent case in Switzerland, new regulations have been put in place to recognize, velotaxis and Segways as transport means that could share the road with cars or, alternatively use the bike lanes where available. This stands in contrast to other vehicles, e.g. solowheels, electric skateboards, hoverboards, which are banned from using sidewalks by the Pedestrian Association, defending 'pedestrian surface at the pace of footsteps' and thus struggle to be identified as a means of transport on the public roads. While e-scooters have been adopted more widely in the last few years. However, their use and application have been perceived as chaotic and dangerous, representing an 'invasion' that cities have to cope with.

The legalisation and policy regulation of most of these devices remain the subject of much debate worldwide, and are a major reason why they still struggle to find their space on the streetscape and lack a visionary adoption plan at the network level. Drawing upon the notion of *the sphere* (Sloterdijk 2004, 2011, 2014), we seek to create new perspectives that can help to rethink the embodiment of micromobilities by streets. The following section provides an overview of spheric conceptions and metaphors within mobilities studies and connects it to analytical approaches by Goffman (1972) and Sloterdijk (2004, 2011, 2014).

3. The notion of sphere and mobilities studies

A challenging aspect for federating discourses and policies for the integration of in-between vehicles into urban mobility schemes stems from their variety in terms of physical characteristics, space requirements, speed, and mode of interactions. We adopt the notion of sphere to bring these variables into a unique analytical framework, and particularly to position and compare the social and spatial conditions associated with each vehicle type. Different spheres create different conditions of exposure to other vehicles, people, and the environment (te Brömmelstroet et al. 2017). Given the long history of spheric metaphors in social sciences, in the following we will first, present a brief overview of the spheric imagery and associated metaphors that have been employed in mobility studies and the automobility literature. We will then describe how this notion can be used as an analytical tool for the case of emerging micromobilities.

3.1. The sphere of the car

In mobility studies, various spheric images have been used to emphasize the idea of insularisation in automobiles (Gartman 1994; Urry 2003; Nixon 2014). John Urry described the experience of the car as 'being *encapsulated* in a privatised, cocooned, moving capsule.' Underlying that 'within the private *cocoon* of glass and metal intense emotions are released in forms that would otherwise be socially unacceptable' (Urry 2003). Urry highlights both the enveloping experience and the frontiers constructed by the car, which go beyond a physical barrier and create a private atmosphere, disconnected from possible disturbances of other mobile vehicles and groups. Such encapsulation contributes to the construction of a space for emotions and communications (Sheller and Urry 2006, 218; Bissell 2010). This enclosed environment of the car generates 'social disconnections' (Nixon 2014; Freund and Martin 2007). Hence, the private space of the car forms an antagonist to *public space* which is the quintessential social space of the city, the space of interaction with and exposure to alterity (Lofland 1998). In her pioneering analysis of public space, Lyn Lofland (ibidem) refers to the car as a cocoon of privacy, 'private realm bubble with hard shell' that allows its passengers to encounter the city while at the same time avoiding it (Lofland 1973, 136).

3.2. Spheres: from metaphor to analytical tool

Erving Goffman (1972), interested in the interaction order and behaviour in public, uses the metaphor of *shell* to analyse the different social occasions created by different vehicular units. 'A vehicular unit,' Goffman (1972, 6) explains, 'is a shell controlled by a human pilot, varying according to the thickness of their skins.' There are trains, trolleys, and cars with thick skins, being guided by individuals who are well hidden and in some ways well protected. There are open cars, rickshaws, buggies, and bicycles, which leave the navigator relatively exposed. Finally, the individual himself/herself can be considered 'a pilot encased in a soft and exposing shell, namely his clothes and skin' (Goffman 1972, 7). Goffman considers the pedestrian as a vehicular unit, in order to be able to sketch out the similarities and differences between car traffic and foot traffic that can be objectively measured and compared. He contrasts the soft skin of the pedestrian with the car's hard iron shell. 'The more protective the shell, the more the unit is restricted to simple movements,' which explains the immense flexibility of a pedestrian compared to a car's relative manoeuvrability. The shell strongly embodies the presence of a separation skin, creating a privatized atmosphere. It, therefore, distances and protects the pilot from the surrounding environment and from other vehicles. However, it also mediates the relations with the exterior. From this point of view, each vehicular unit creates a different social condition by the virtue of its different physical and spatial characteristics. Hence, the separations and communications, or the 'differences in potential exposure' (te Brömmelstroet et al. 2017, 2), are fundamental characteristics that can be relied upon to describe different vehicular units.

Building upon Goffman's analysis to account for various features of a vehicle, we further draw on Peter Sloterdijk's work on *Spheres* (Sloterdijk 2014, 2011, 2004). The philosopher takes the spatial notion of the sphere to describe ontological relations. He studies the elements composing a sphere not merely as a protector from the exterior environment but also as a provider of internal space. To inhabit, according to Sloterdijk, is to construct a container or a dual reality, which he calls a sphere.

This can be an architectural space, a vehicle, or a conversation. Sloterdijk's definition of sphere permits the description of the richness of the socio-technical apparatus, explaining the extent to which the vehicle is simultaneously connected to and disconnected from its immediate surrounding environment. Spheres are atmospheric envelopes that interact through their membrane. A membrane is a filtering, separating and transmitting object, thus it is a selective barrier. The application of such an understanding to transport modes, allows us to compare a car's iron frame and windshield, to a cyclist's helmet, or a pedestrian's clothes and skin. However, according to Sloterdijk the spherical conception goes beyond the physical and material skin. Music for instance, is a perfect example of an atmospheric design. Creating both an emotional atmosphere and auditory space, music in the car reinforces the internal space. Headphones are often cited among insularisation techniques for the pedestrian, strengthening civil inattention in public (see, e.g. Hagood 2011). Similarly, microclimates, olfaction and vision can reinforce and impact the membranefor example, in vehicles with tinted windows. Sloterdijk also highlights spheres as immunity systems (Sloterdijk 2009, 235). The immunity, that is the mechanism of biological and social auto-defence preventing harmful confrontations with others (Rauschenbach 2011), depends on the filtering of the membranes. On a collective scale, co-immunity is attained by collaboration and self-limitation. Throughout 2020 and 2021, amidst the Covid-19 pandemic and social distancing guidlines, the spheric properties of the moving individuals have become clearer than ever. Physical distancing as a means of creating co-immunity was reinforced by the shell and constituted by the use of face masks and their filtering properties. In the words of Sloterdijk, we are transformed into 'responsible collaborators for the set-up of a global architecture of co-immunity' (Sloterdijk 2009, 713).

Applying Sloterdijk's notion of the sphere to transportation and mobility, we additionally need to account for the pace of movement. A determining factor influencing how a vehicle relates to its immediate context stems from its speed of travel. The car's speed in combination with its robust shell, has been associated with 'road rage' in the sociology of mobility. Cars have been described as 'speeding capsules of alienation' (Nixon 2014; Freund and Martin 2007), where 'the environment beyond the windscreen becomes an alien other" (Urry 2012, 63). In contrast, when a car slows down in the city centre, it softens its sphere to some degree, thus even being capable of creating meaningful social occasions of exchange and encounter (see Bahrami 2016).

4. Interviews on mobility experiences

In this section, we draw on the mobility experiences of 53 interviewees. We present an exploration of vehicles' properties, especially highlighting the expressions of metaphors within the description of mobility experiences and particularly on their spheric representations.

4.1. Subject of interviews and selection of interviewees

The interviews were conducted as part of a multi-institutional research project in Switzerland, called *PostCarWorld*.[13] They were specifically designed to probe futures of mobility through the changing role of cars in Switzerland, testing the hypothesis of a radical transition from cars. Each interview lasted about an hour and the questions probed three broad topics: 1) mobility biography, 2) mobility practices and potential improvements at an individual scale, and 3) mobility's future at any scale. This allowed us to start with the individual experience and everyday practice, and conclude with future aspirations and imagination.

The interviewees were recruited from the three agglomerations of Zurich, Lausanne, and Geneva based on the diversity of their mobility practices and their residential location to include various gradients of urbanity from city centres, urban peripheries to alpine localities. Out of 53 interviewees, 19 identified as women and 34 as men. The age range of 25 to 54 represents the dominant population (28 interviewees) while 12 interviewees were younger than 25 and 13 were above 55. Twenty-eight participants lived in an urban-centre area, 17 in urban peripheries, and eight in small villages.

According to the Swiss federal mobility survey, within the last two decades the share of walking and cycling has increased in these territories through a modest but consistent trend. In the city centres of Lausanne and Geneva, four out of ten families move around without a private car and nearly 50% of all trips are carried out by walking. As we move further out from the centres to areas classified as peri-urban, the number of car-less families drops to less than one per ten households. Despite the prevalence of car ownership in these low-density areas, the modal split of walking has increased steadily. In addition, 7% of the households possessed an e-bike in 2015. In Switzerland, public transport is also among the best in Europe, and innovations in mobility as a service have already been at work for a few decades. To summarize, the choice of the territories of inquiry offers favourable grounds for the exploration of multiple currently existing and future mobilities, and for the discussions of a wide range of travel experiences beyond the car.

It is worth noting that since the questions were designed to discuss a variety of mobility experiences, the interviews do not offer direct comparisons between multiple transport modes. Nevertheless, dual comparisons appeared in some of the responses, especially comparisons between the car and other transport modes. In addition, the qualitative interviews are not representative of the attitudes of individuals based on where they live or travel (e.g. exurbs), or of their socio-economic status. We have adopted in-depth interviews and have chosen to highlight the diversity of mobility experiences over the representativity of the practices.

4.2. Analysis of interviews and results

The interviews were designed to probe the mobility practices and aspirations of the inhabitants with no reference to or questions about the spheric conceptions of vehicles. Nevertheless, spheric images as the *bubble* and the *capsule* were mentioned in several cases directly, often within the context of cars but also when describing walking and cycling experiences.

Thomas (41, civil servant, car): The car feels like a bubble, and I like the bubble thing. Then, on foot, I am in my head, so it feels like a bubble too (laughs).

Kevin (20, apprentice, car): I have discovered a new bicycle system. It is like being in a capsule and it is very fast.

In addition to using direct spheric metaphors, some of the interviewees referred to the internal atmospheres of vehicles using words like *environment* and evaluated their level of separation from the surrounding, or immersion into it, mentioning the light exposure, smell, or the quality of air, as well as the exposure to others or the environment.

Kevin (20, apprentice, scooter): [A car] is a sort of closed room that is yours, a kind of mini apartment on wheels, you know.

Dominique (38, musician, walking): I like trains. I don't want to be inside my bubble [. . .] I like speaking with others whenever possible but it is difficult.

Various techniques, like layered clothes, were put forward to control this exposure through reinforcement or alleviation of the membranes.

Denise (49, PhD student, bike): I dress in layers. That is my strategy. At the beginning, I like to feel warm a bit, then I take things
off.

Recurring references to clothing layers by interviewees confirms Goffman's characterization of vehicular units based on a broad definition of the skin or shell (See Section 3.2.). For active travellers, a layering strategy is a response to the weather conditions but is also linked to the physical effort required for transportation (Cook et al. 2016; Bahrami and Rigal 2017), suggesting a relation between atmospheric design, effort, and mode choice.

Pierre (25, student, walking) Going downhill is fine. It is important not to sweat a lot when we go to work, or not to be disgusting when it rains.

Physical properties of the vehicle condition the extent to which one feels the movement and becomes an active part of it. Describing the experience of traveling within thick-shelled vehicles, some of the interviewees suggested a decoupling between the movement and the perception of the movement. The locomotion and its perception were largely decoupled when speaking about cars. This is not a binary distinction between motorized and non-motorized vehicles is further influenced by the vehicle's shell.

Lia (24, student, walking): The car is very restrictive. You sit in a thing and you move without using your body.

Virginie (39, social worker, bike): By car it's comfortable, but one is in one's bubble. One doesn't socialize. While by bike, something I love, is to have small talks with other bikes.

Werner (63, retired, car): Driving a motorbike is different from a car. The car is a means, but the motorbike, you feel it, you feel yourself driving. The feeling is different.

Such experiences of moving can be classified in a spectrum from walking, where the vehicle is the body itself, thus presenting an immersive and multi-sensorial experience, to autonomous cars as paroxysmal decoupling. In between these two extremes, there exist different levels of agency and engagement with the environment. This quality transforms and shapes the experience of mobility. Ingold (2007, 81) distinguishes between wayfaring and transport as two different modalities of travel: Insularisation of the vehicle and motorization, both contribute to the decoupling between locomotion and perception. The experience of decoupling was sometimes valued by interviewees, resulting in the extreme of wishing for *teleportation* technologies in the future. Other interviewees valued experiences closer to wayfaring.

Denise (49, student, bike): Once I received a moped as a gift and I sold it to buy a bike. I used to get bored on the moped. It is boring to simply sit there. I need to move!

Patrick (50, woodworker, van): I have thought about electric vehicles, like Twike. It would also be okay for Toto [his dog]. It would be great to be able to go to Ticino with it, with a Twike it takes 4–5 h.

Lighter shells provide greater exposure to both the material and social environment. Flavia described the pleasure of being *in the open air* when she rides her bike. A few interviewees also mentioned the pleasure of riding with kick scooters. Jean-Philippe wished to roller-skate on the highway during Carfree Days. The recreational character of certain vehicles is revelatory of their potential for coupling locomotion and perception. Besides exposure and flexibility, they provide opportunities for unplanned serendipitous events, which are more likely to happen in dense and diverse spaces (Demerath and Levinger 2003, 217). This aspect was partly the motivation for Jacques, a journalist eager to experience novelties and unplanned features, to walk long distances daily (more than 5 km per day). He prefers living in urban settings, where the potential for serendipity is high. This experience was summarized by Pierre, feeling that *the world is opening* when he walks.

Pierre (25, Ph.D. student, public transport): You create a relation with your space, different from the car, which is very structured. It entails more accidents in every sense. It is more dangerous to ride my bike than being in a car. You also experience unplanned events. You can stop and say 'hello' to someone, many things can happen. When you take a journey by bike or even walking, a journey is never twice the same.

Moreover, the flexibility conferred by lighter shells enables the merging of spheres where lighter shells can be nested into heavier ones. For example, one of the interviewees mentioned the difficulty of travelling with an e-bike on trains, while another explained that as a cyclist he could always switch to walking and become a pedestrian at any moment. Thus, lighter shells also provide more agility for the user to navigate on the streets and within the network of public transport. Hence, lighter shells are compatible with the city defined by its public space, and its high density, i.e. a high number of potential encounters. Micromobilities are ideal transport modes for creating crowds without leading to congestion.

The interviews revealed the presence of spherical imagery in the descriptions of the travellers. The atmospheric experiences and the communications with and separations from the immediate environment were discussed across different transport modes. Overall, the analysis of interviews suggests the potential of deploying the spheric approach for discussing the spatialities of vehicles.

5. Analytical framework for classification of vehicles: a spheric proposal

As stated initially, the aim of this work is to account for the variety of micro-vehicles that despite their increased use and market success have so far remained marginal within the mobility discourses and consequently lack proper recognition within the traffic regulations, road signs, facilities, and street space planning. We seek to develop an overarching description that can cover a large spectrum of vehicles from man-powered small devices, such as rollers, kick scooters, to the portable electrically-powered ones as solowheels, e-scooters, and further to e-bikes, cargo bikes, rickshaws, and mini cars. To do so, the first step is to identify the spheric characteristics of the micromobilities based on the quality of users' experiences (qualitative interviews). The second step is to provide a framework that allows for comparisons across micro vehicles, and with other more established categories of transportation, e.g. cars, bicycles, and subsequently, facilitates their integration into discourses, projects, and spatial policies.

Classifying is a basic scientific task that is useful for achieving a synthetic view of a complex topic: by recognizing, differentiating, and understanding a phenomenon, it enables discourses, new imaginaries, and projects. Drawing on Sloterdijk's notion of the sphere, we propose that considering each vehicle as a sphere allows for a potentially useful classification. In the previous section, we explored spheric metaphors and properties in different mobility experiences in a set of qualitative interviews. Separations from and communications with the immediate environment proved to be fundamental determinants of mobility experience, confirming the existing literature on how vehicular units shape travel experience (te Brömmelstroet et al. 2017) and relations in public (Goffman 1972).

5.1. The shells of micromobilities

The physical envelope of a vehicle, its *bubble*, is recognized by the interviewees as a determining factor for how a vehicle can impact its surroundings and interact with other mobile elements on the street. Acknowledging this perception, in order to have measurable and commensurable criteria, we suggest accounting for both the vehicle's volume and its weight. Together these two criteria form the *encumbrance of its shell*. The weight reflects the materiality of the vehicle and accounts for the level of potential danger to the road users in case of collisions and the energy required to propel the vehicle itself. For example, a velotaxi, because of its low weight, embodies a different shell compared to a passenger car, regardless of their comparable volume. On the other hand, the volume determines the space consumption of the vehicle as well as the visual field it blocks. These two characteristics already provide important parameters for sketching a classification of vehicles based on the encumbrance of the shell as a combination of the vehicle's weight and volume. (Figure 1) presents a continuous gradient of vehicles – in a Beeswarm diagram – distributed on the horizontal axis based on their weight, while the area of each circle represents the volume of the vehicle. Taking these vehicles as an example of possible road users on an inclusive and complete street, we can recognize clusters of different ranges of vehicles. In this classification, even the smallest city cars have disproportionately heavier spheres relative to micro-vehicles including rickshaws and velotaxi. Therefore, given the above-described spheric approach, the main distinguishing factor for micromobilities appears to be weight. The volume, however, points to being a defining variable for discussions on the differences of various forms of micromobility. In (Figure 1), we distinguish between three clusters of micro-vehicles based on their volume.

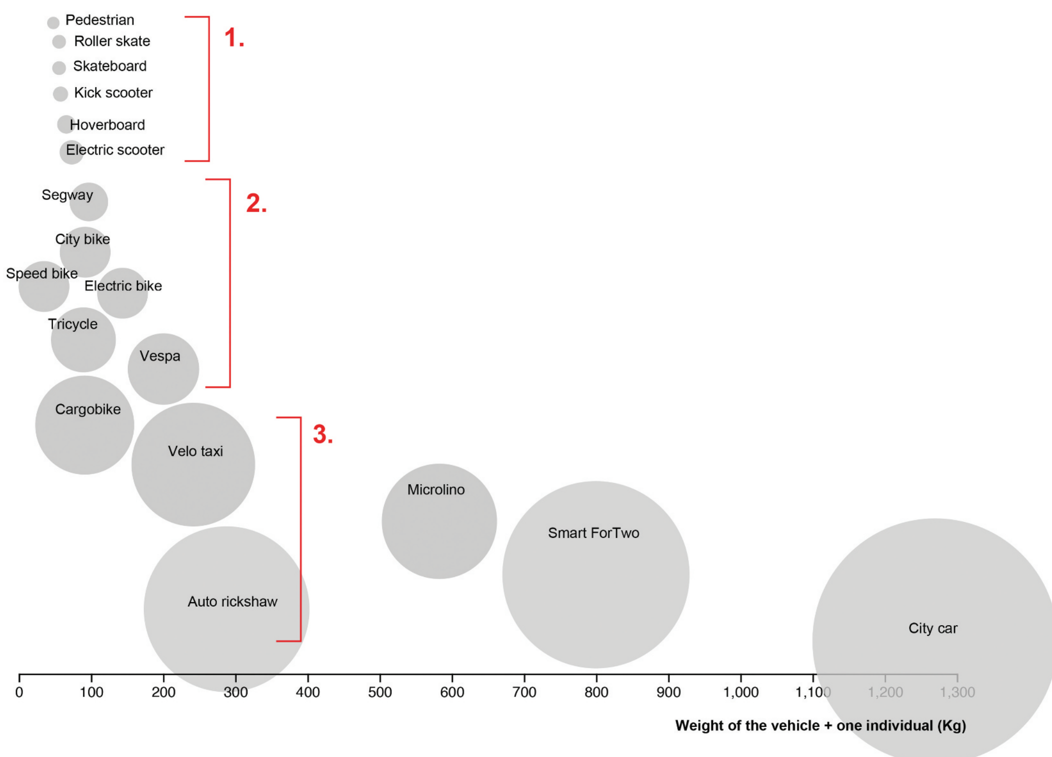

Figure 1. Vehicles are classified based on their volumes and weights. Beeswarm diagram (Clarke 2015) presents the distribution of vehicles based on their weight (kg) on the horizontal axis. The vertical dimension is used to avoid overlaps among circles, showing their distribution. The area of circles represents the volume of vehicles. The weight is calculated with one average individual (70 kg) referring to the table proposed by Héran (2018).

The first cluster consists of small vehicles that change the shell of the human (pedestrian) only slightly: examples are small kick scooters, solowheels, and hoverboards. They can be interpreted as 'augmented' pedestrians without fundamentally changing the features of their shell. The second group of micro-vehicles encompasses various kinds of bikes and heavier motorized modes, such as Gyropodes. Depending on the model and design, e-scooters can be positioned at the borderline between the first and second cluster. The third category consists of more voluminous vehicles which are comparable to small cars but can be placed with other micro-vehicles, e.g. auto-rickshaws and velotaxi, in terms of their weight.

5.2. Towards a dynamic model of sphere

The spherical model that we employed in the last section and in (Figure 1) to extract the defining variables of micromobility is limited to the static features of vehicles. However, a vehicle in the words of one interviewee is not only *a closed room* but also an *apartment on wheels*. The speed of travel is another fundamental factor determining how a vehicle relates to its immediate context. Interviewees mentioned the pleasure of riding fast e-bikes, or the privilege of the slow pace of walking. Variations in speed can change both the interaction with other vehicles as well as the space consumption of the vehicle, i.e. the space requirement per unit of time, regulated by the required safety distances. The consumption of the circulation space for a car at 130 km/h is 3.5 times higher than at 30 km/h (Héran and Ravalet 2008, 70). Higher speed weakens the interactions of the internal space of the vehicle with its surrounding. Together, speed and the physical shell determine the features of the vehicle as a sphere, the visual field, and the soundscape. There is often a link between the two, as speeding at higher levels calls for a more protective and robust shell.

Micro-vehicles cover an extended range of speeds, from very similar to the pace of running (10–12 km/h), reaching 40 km/h and more for electric micro-vehicles. Figure 2 illustrates and compares the space consumption of different vehicles at two different speeds. The space consumption is calculated based on the vehicle's surface occupation plus the sum of braking and reaction distance at a certain speed. We have calculated this for two different speeds: the maximum speed that the

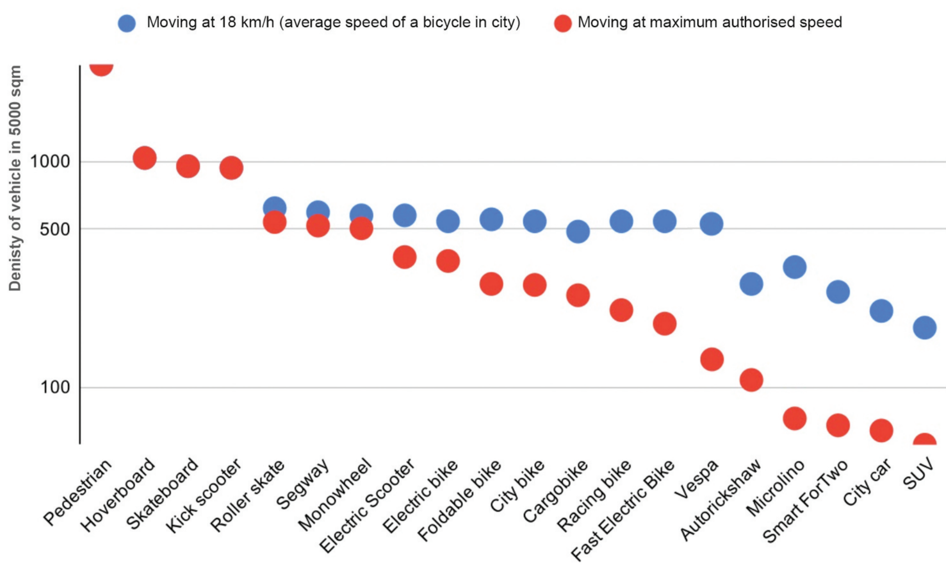

Figure 2. Vehicles are based on their density in space at two different speeds. The vertical axis presents the number of vehicles that can fit in a space equal to 5000 m2 (e.g. 10 m × 500 m) moving at two different speeds. Speeds are selected referring to the table proposed by Héran (2018).

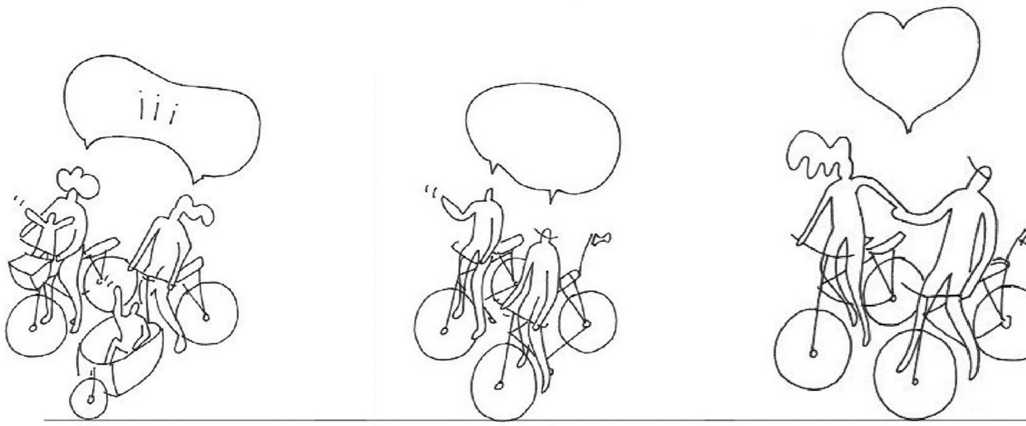

Figure 3. Co-isolation of vehicles: creating a common sphere. Drawing © Enrique Enriquez.

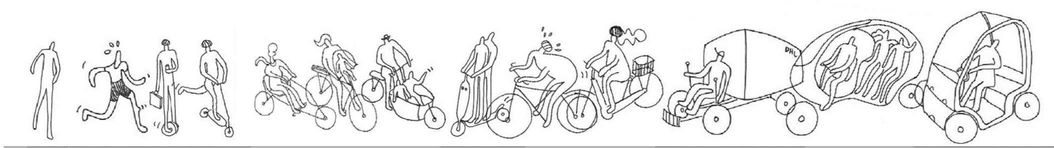

Figure 4. Transport modes characterized by agility. Drawing © Enrique Enriquez.

vehicle has been authorized for the city, and as a reference speed, the average speed of the bicycle in the city (18 km/h). Having identified the space consumption for each vehicle, the graph shows the number of vehicles that can fit and move safely within a determined space (5000 m2). Comparison of the density of the vehicles in a hypothetical road section (width: 10 m; length: 500 m) provides an understanding of the spatial occasion created by each vehicle while moving at these two speeds. In the case of some of the vehicles, like kick scooter or pedestrian, the maximum speed of the vehicle is below 18 km/h, so they are displayed only once and with their maximum speed (Red). The diagram is an attempt to represent vehicles based on their encumbrance of shell and speed in relation to the street space.

The diagram confirms some well-known characteristics of road users, and it reveals differences and thresholds between the vehicles. Walking stands out as the most spatially efficient mode, highlighting that despite its affinity with other small micro-vehicles in terms of the shell (Figure 2), the pedestrian has a unique way of occupying space and maintaining density. Walking is the urban mode of transport *par excellence*. This result confirms the choice of one of the interviewees (Jacques): 'walking for experiencing the city'. The relative linearity of the circles in blue, on the other hand, suggests that the problem of space in cities is in fact the problem of speed, confirming that 'speed distribution on the street is not only the distribution of time among modes but also distribution of space' (Peters 2006, 137). Thus, rather than serving the introduction of rigid categories, the thresholds identified in the diagrams are conducive to a better understanding of vehicles and to underline the challenges of their cohabitation and space requirements.

In the remainder of this section, we consider all of the three constituents of the spheric approach – speed, volume, weight – to structure a more elaborate discourse surrounding the cohabitation of micro-vehicles and the multifaceted benefits of their adoption.

5.3. Cohabitation of micromobilities

The cohabitation of micro-vehicles within the existing layout of streets has proven to be challenging: menacing walkers on sidewalks and creating safety concerns on roads. During the interviews, both drivers and non-drivers complained about the existing order and interactions with other road users even in Zone 30 in Switzerland. Following the spheric approach and to provide the conditions for cohabitation of vehicles, we need to account for the combination of the vehicles' shells and their travel speeds within the limited available space of the streets. A relevant example of how speed can leverage the place of a vehicle on the street and its cohabitation with other vehicles is provided by light mopeds or Vespas. Vespas appears in bordering situations in both (Figures 1 and 2), placed between the cluster of bikes and the cluster of the more encumbering vehicles, e.g. auto-rickshaws. In many Dutch cities, a light moped (*snorfietser*) is authorized to travel on cycle paths up to a speed limit of 25 km/h. This, however, has been controversial over the years mainly due to the frequent speed limit violations by users but also because the heavier body of Vespa becomes intimidating for cyclists in the narrower sections of cycle paths. Hence, the cohabitation of Vespas and different types of bikes is sustainable only when space is abundant and when speed limits are respected. However, effective from 2019 the city of Amsterdam banned scooters and mopeds from its cycle paths.

As mentioned in the previous section, Figure 2 unveils pronounced differences between various types of cycling, where variations in space consumption in relation to their speeds are not negligible. This indicates that with the increasing practice of cycling and its diversifications, the cohabitation of different types of bikes can present a challenge. Different speeds correspond to different types of bikes, e.g. city bike vs. e-bike, and represent different purposes and demographics ranging from cycling for fast commuting, electric cargo bikes for deliveries, to families cycling with children, or elderly people on tricycles. Therefore, the space requirements for accommodating this vast gradient of vehicles goes far beyond the current standards of minimum cycle path widths. A spheric approach to vehicles conceptualizes the street as an ecosystem where spheres of various sizes and textures can move, interact, and even merge safely. In this perspective, if cycle lanes are about to become micro-mobility lanes new standards are required, larger widths, speed regulations, and use conventions. This calls for reimagining the street sections as new road typologies with different levels of acceptance and penetration of cars, and in general, a new generation of road infrastructure.

5.4. Co-isolation of micromobilities

We have so far established that a sphere is a relation. Described as atmospheric envelopes, spheres interact with one another through their membranes, gain collective properties and create different types of co-isolation (Sloterdijk 2004, 864). Sloterdijk's reflections on distances and proximities in human interactions suggest the unification of human bubbles at certain distances.

Sharing the same speed and rhythm of movement, two vehicles, e.g. two runners or cyclists can interact with one another more intensely and can create a common sphere. This is subject to the permeability of their sphere. The protective shell of the car does not provide this opportunity. In contrast, cycling together can create a strong social occasion by creating the condition for *co-isolation*. The pace of travel relatively detaches cyclists from the surrounding context and thus reinforces the sense of unification of their spheres when traveling together This quality increases the opportunities for social connections (te Brömmelstroet et al. 2017). The commute from work to home locations, for example, can become a social occasion for colleagues on their bikes when they can unify their spheres. That could be the case when the road infrastructure provides the opportunity for cyclists to ride side-by-side and have time and space for engaging in a conversation. As such, the shared travel experience becomes comparable to sharing a car ride. The ability to co-isolate for active modes heavily depends on the abundance of space available and is a determining factor for the experience of mobility. For example, as an expression of affection[14] cyclists holding hands is a common practice across Dutch cities. Co-isolation of micro-vehicles reinforces their spheres, yet, the degree of privatization of public space remains low. It creates crowds without creating congestion (Figure 3).

5.5. Agility of micromobilities

Determined by their volume, their speed capacities, and the degree to which they privatize public space, micromobilities are defined as vehicles placed between the pedestrian and the car. However, they are not always in-between. Illich (1974) has extensively and famously written about the efficiency of the bicycle and how it outperforms both pedestrians and cars. Micro-vehicles are often more *agile* than both walking and driving.

Agility means quick and light in motion; having resourceful and adaptable character, from Latin *agere*, sharing the root, *ag-* with action and agency. In the context of transportation, agility can be defined as continuity and smooth transitions between spaces, modes, and speeds to best adapt to the intensity of the context (Bahrami 2017). Less cumbersome and more penetrating, manoeuvrable, and flexible than the car, micro-vehicles have a higher capacity to mediate between different spaces and speeds, and to better adapt to the context. As pointed out by interviewees, smaller and lighter vehicles can merge their sphere with other vehicles (taking bicycle and scooter on the train or walking with the bicycle in crowded public spaces). Being adaptive to the surrounding environment, one of the interviewees explains that she only makes use of the electric assistance of her e-bike to speed up in the countryside – where she goes regularly to take care of her beehives – while in the city, her bike becomes a normal bike. This flexibility creates close responsiveness between the system of the mobile elements and the urban context of the travel. Agility, therefore, is a compromise, i.e. an optimum point, between speed and encumbrance of the shell. It is a primary comparative advantage of micro-vehicles to cars and a quality that makes them promising for the density and diversity of cities (Figure 4).

6. Conclusion: implications for cities

Understanding vehicles as socio-spatial spheres can have strong spatial implications. The space occupancy of the vehicles in transportation literature is measured in terms of occupied surfaces of the road, whereas, a spheric understanding of vehicles accounts for their spatial impact along three dimensions. This change of perspective can stimulate reconsiderations of spatial relations on the streets and trigger a new agenda for streetscape design, specifically towards reverting the current trend of increasing the size of vehicles.[15]

Planning for the diversity of road users and the inclusion of micro-modes – as opposed to the dominance of cars – requires redistributions of space at the street level, as well as a rethinking of the road network. The application of the spheric approach to vehicles emphasizes the imperative of lower speeds for vehicles with hard shells. It illustrates that more encumbering vehicles are not just consuming more space through their physicality, they also alter the mobility experience of other road users and disrupt the social space of the city. Micro-vehicles characterized by their agility, that is their swift pace and soft-shell, keep a high level of connection to their immediate environment. The road infrastructure that hosts them does not introduce strong canalizations. They are free from heavy infrastructural features, and are based on functional synergies between the elements of the urban context (Parolotto and Arcuri 2015). Hence, they contribute to the diversity of the environment rather than merely consuming and privatizing the space. In this perspective, the road network adapted to micro-vehicles is characterized by permeability and porosity and establishes a programmatic relationship of continuous exchange with its context.

The integration of micromobilities within urban mobility, given their diversity and their space requirements, cannot be solely achieved through 'micro interventions' and with minor policies. In this perspective, the scale of intervention for visionary integration of micro-vehicles is a determining factor. As we discussed in Section 2.1., the failed attempts of reinventing urban mobility with a focus on micro-vehicles in the previous century stemmed from a lack of large-scale vision. Envisioning a transition from car dominance implies reversing the perspectives towards cities where a limited but carefully designated network of roads for cars and trucks, serving essential access axes, are provided as an exception rather than a norm. The major part of the road network, in this hypothetical future city, can be dedicated to lighter and more open urban vehicles, where cars are admitted only exceptionally or with reduced speeds.

The proliferation of vehicles that constitute soft and open spheres, designing and providing for their cohabitation, can reinvent the street as vibrant and liveable public spaces and overcome the perceived duality of civility and mobility (Sheller and Urry 2000), that is streets as good places versus streets as mobility corridors. Furthermore, projecting a wider adoption of micro-vehicles, one can foresee opportunities for the advancement in the active mobilities. This is not only associated with the hybrid character of these vehicles, combining human effort and mechanical or electrical engines and their propensity to be a part of intermodal trips, but more importantly for their spatial consequences, that is, to create more co-habitable, safer, less polluted, and more social streets that encourage and entice more active and very active mobility.

Notes

1. https://nacto.org/wp-content/uploads/2020/08/2020bikesharesnapshot.pdf (Accessed 11/03/21).
2. https://bisresearch.com/industry-report/global-micro-mobility-market.html?utm_source=Statista (Accessed 11/03/21).
3. In the United States and even more in Western Europe, we observe the rise of one-child and single-parent families https://www.pewsocialtrends.org/2015/12/17/1-the-american-family-today/ (Accessed 26/05/20).
4. People living alone make up 28% of households in the United States and 40–45% in Sweden, Norway, Denmark, and Finland – Source: Eric Klinenberg, Going Solo: *The Extraordinary Rise and Surprising Appeal of Living Alone* (New York: Penguin, Klinenberg 2012), 5, 10.
5. Among many other electric home appliances that were becoming popular in the post-car: https://www.ina.fr/video/I14267037/l-oeuf-electrique-de-paul-arzens-video.html. (Accessed 26/05/20).
6. 'Brian Richards, Architect with a rare devotion to transport design', https://www.independent.co.uk/news/obituaries/brian-richards-26400.html (Accessed 26/05/20).
7. The "Heart of the City" was the title of the 8th Congrès Internationaux d'Architecture Moderne (CIAM), held in Hoddesdon, England (see Rogers et al., 1952) and replace in bibliography the reference Congrès Internationaux d'Architecture Moderne (CIAM) VIII. 1951. *The Heart of the City: Towards the Humanization of Urban Life*. Hoddesdon, England. with the book Rogers E.N., Sert J.L., Tyrwhitt J., Editors, *The Heart of the City: Towards the humanization of Urban life*. New York, Pellegrini en Cudahy, 1952.
8. The presence of the theme of 'future' in urban projects disappears between 1970s to late 1990s before remerging in early 2000s (Rouillard 2009).
9. 'Des trottinettes en libre-service gratuitement pour se déplacer autrement', Franceinter, 2017, https://www.franceinter.fr/idees/des-trottinettes-en-libre-service-gratuitement-pour-se-deplacer-autrement
10. '21ème édition de l'observatoire du Cycle', https://www.cyclable.com/wp-content/uploads/2019/04/dossier-de-presse-observatoire-2019_1459257958.pdf (Accessed 25/05/20).
11. https://maas-alliance.eu/cargo-bike-industry-survey-expects-over-50-market-growth-in-2020/ (Accessed 04/22/2021).
12. https://www.swissinfo.ch/eng/mobility_coronavirus-fuels-swiss-bicycling-surge-/45785258 (Accessed 04/22/2021).
13. https://archiveweb.epfl.ch/postcarworld.epfl.ch
14. Pedal brakes (Coaster brake) of the typical Dutch bicycles play a role by liberating the hands of the cyclists.

15. In the last couple of years, the Sport Utility Vehicles' sales have been rising constantly worldwide. They outsold sedans two to one in 2019, just four years after surpassing them for the first time. (See: https://www.nytimes.com/2020/05/21/business/suv-sales-best-sellers.html)

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ORCID

Farzaneh Bahrami http://orcid.org/0000-0001-6564-3048
Alexandre Rigal http://orcid.org/0000-0002-5096-0179

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