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Car independence in an automobile society? The everyday mobility practices of residents in a car-reduced housing development

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ABSTRACT

Lately, transport researchers and practitioners are showing renewed interest in car-reduced neighborhoods and their residents' mobility to investigate possible factors influencing sustainable transport. With a biographically inspired practice-theoretical approach, this study considers the 'context of travel behavior' and, thus, focuses on mobility as a 'practice' in order to improve the understanding of everyday mobility as well as the potential and limitations of implementing car-reduced housing. Based on qualitative interviews with residents of two German car-reduced neighborhoods, we first identify different compositions of materials, competences, and meanings (including the feelings and emotions) of car-(in)dependent mobility practices. Second, we discover the personal, social, temporal, and socio-structural circumstances of the residents' travel behavior alongside 'practice bundles' that interact with car-(in)dependent mobility. Finally, our findings indicate, on the one hand, that the car-centric material context outside car-reduced neighborhoods, the incorporation of private car driving with the practice of everyday life, and the affective satisfaction with car use and ownership negatively influence car independence. On the other hand, our results highlight that residential location and its materiality in the case of car-reduced housing developments, as well as the personal-temporal and socio-cultural contexts of their residents' mobility practices stabilize and support car independence and low-carbon mobility.

1. Introduction

Principles of sustainability have become increasingly important in urban and transport planning and policy in order to reduce car dependence (Banister, 2011; Buehler et al., 2017; Hickman et al., 2013). With their emergence in Western Europe in the 1990s, car-reduced housing developments – also referred to in the literature as car-free, car-lite or low-car(bon) developments, private-car-restricted and mobility-served neighborhoods or areas with low or maximum parking requirements (Basu and Ferreira, 2020; Foletta and Henderson, 2016; Johansson et al., 2019; Melia et al., 2010; Sprei et al., 2020) – are an increasingly important concept for a 'new post-car system' (Dennis and Urry, 2009). As Baehler (2019) and Melia (2014) summarize, there is no universal definition of such residential developments. Despite different emphases, the concepts previously mentioned have the following aspects in common that we consider characterize a car-reduced neighborhood in a European context. First, they limit car parking supply or private car ownership and/or separate parking from housing. Second, they enable

residents to live without owning a car by providing infrastructures supporting non-motorized, public, and shared mobility practices instead of private car use (Baehler, 2019; Melia et al., 2010). The term 'car-reduced' refers to the neighborhood's aim to reduce the car use and car ownership of its residents and, thus, to address parking problems in residential areas. This can best be achieved by combining restrictive and incentive-based transport planning measures (Melia, 2014).

Despite the benefits of car-reduced planning principles in general, e. g. the reduction of car traffic, air pollutant emissions, noise, and land consumption, and, thus, the creation of green, livable, and healthy cities (Nieuwenhuijsen, 2020; Nieuwenhuijsen and Khreis, 2016; Ornetzeder et al., 2008), they are still rarely implemented. While there is currently an increase in car-reduced housing developments in some European countries, they also still remain a niche concept. This is because they are often limited to small sites or mostly only developed in inner areas of (larger) cities (Baehler, 2019; Melia, 2014)[1]. This underlines the hegemonic 'system' of automobility (Manderscheid, 2014; Urry, 2004) and the 'car-dependent society' (Jeekel, 2013). Hence, in a 'hegemonic car

culture' (Sattlegger and Rau, 2016), Kent and Dowling (2018, p. 1) argue that "willingness is central to mobility transitions". Further, Thomsen and Löfström (2011) claim that people's 'willingness' to use alternative transport modes to the car seems to play a key role in the success of car-reduced housing developments. Therefore, Oostendorp et al. (2019) argue that a closer look at the everyday mobility practices of the residents in this type of development is needed in order to evaluate whether they are accepted by the residents and actually demonstrate the effects expected. So, taking the perspective of the residents and their daily practices can improve our understanding of the potential and also the limitations of implementing such neighborhoods. This can then be taken into account for further developments (Freytag et al., 2014; Selzer and Lanzendorf, 2019).

Therefore, our study asks which mobility practices are present in car-reduced housing developments and what these practices comprise in terms of materials, competences, and meanings. Following Greene and Rau (2018) and Rau and Sattlegger (2018), this study empirically applies a biographically inspired practice-theoretical approach. Accordingly, our study understands mobility as a routinized and knowledge-based practice (Shove et al., 2012), related to emotions as well as embedded in other daily practices, and a "wider social, cultural and material context" (Heisserer and Rau, 2017, p. 580). The objectives of this article are, firstly, to develop a practice-theoretical typology to classify mobility practices and how they are performed in car-reduced neighborhoods, and, secondly, to shed light on the relationship between the material, personal, social, temporal, and socio-structural circumstances of residents' travel behavior in order to find out more about the feasibility of car independence, on the one hand, and dependence on the automobile on the other. In this respect, we conducted qualitative interviews with residents of two German car-reduced housing developments in the City of Darmstadt to discover their everyday ways of getting around. This started from their residential location, the built environment, and available (transport) infrastructure (spatial-infrastructural material) as well as personal and household access to mobility tools and equipment (device-oriented material). In addition, we complemented the competences and circumstances of the residents' mobility practices, including mobility biographies and social networks as well as temporal aspects of daily life, and socio-structural contexts in the analysis.

The remainder of this paper is organized as follows. Section 2 discusses the state of research on car (in)dependence and explains the theoretical background of our investigation to study *mobility practices* instead of *individual travel behavior* by presenting the biographically inspired practice-theoretical approach. Next, Section 3 presents the two case studies, research design, and methodology. Section 4 describes the results of our empirical work about car-(in)dependent mobility practices from car-reduced neighborhoods. Subsequently, Section 5 discusses dependence on the automobile and the feasibility of car independence. The article concludes with Section 6.

2. State of research and theoretical perspectives on car (in) dependence

2.1. Travel behavior research: Car ownership, car use, and car-free living

Travel behavior research shows that spatio-structural conditions, such as built environment factors, time restrictions, costs, and accessibility, affect travel behavior (Cao et al., 2010; Ewing and Cervero, 2010). The residential location influences car ownership and, partly, transport attitudes (Næss, 2009). However, this influence is contentious. Individual and socio-cultural factors, such as attitudes, norms, needs, habits, experiences, and preferences, also influence travel behavior (Müggenburg et al., 2015). Thus, to analyze travel behavior change after a residential relocation, a 'residential self-selection' effect has to be taken into account to prevent overestimating the role of the built environment (Handy et al., 2005). This concept assumes that people

organize themselves according to their preferences – concerning their housing situation but also certain transport modes. This is why travel behavior at their new place of residence is not influenced by the spatial structure alone but rather by personal travel preferences and already existing attitudes (e.g. Heinen et al., 2018). In turn, e.g. Cao et al. (2009), Lin et al. (2017), and Mokhtarian and Cao (2008) conclude that both self-selection and the built environment impact travel behavior and car ownership. To summarize, the causality of changes in travel behavior and car ownership level in the context of a residential relocation is as yet difficult to assess (Handy et al., 2005; Sprei et al., 2020). Hence, Næss (2015) argues that a 'single-cause relationship' is not sufficient to fully explain the choice of location and travel behavior.

Mobility biography research is useful to explain the effect of residential self-selection because it offers perspective to understand transport demand and related changes over the life course of individuals (Lanzendorf, 2003; Lanzendorf, 2010; Scheiner, 2018). This approach conceives of individual biographies and experiences as well as changes in people's life courses as important aspects to understand everyday mobility, thus highlighting the temporal and longitudinal dimensions of decision-making in transport mode use. Since travel behavior is, to a strong degree, habitual and relatively stable, the mobility biography approach explains changes by 'key events', like e.g. residential relocations or job changes. Both open a 'window of opportunity' for changes in travel behavior, as changes in the environment and surrounding context weaken routines (Müggenburg et al., 2015). Recent investigations of mobility biography research, however, consider changes in travel behavior as an incremental process over the life course of individuals or households (Rau and Manton, 2016) and, therefore, link biographical changes to e.g. car-free living (Sattlegger and Rau, 2016). Furthermore, mobility biography research combines social-relational approaches (Rau and Sattlegger, 2018) in order to acknowledge the influence of socialization effects through family members (Döring et al., 2014), partner interactions (Scheiner, 2020), or other social networks and social structures around one individual (Cairns et al., 2014; Camarero and Olivia, 2008) on everyday mobility. Social trends, such as digitalization and the sharing economy, are also taken into account as determinants of travel behavior (Holz-Rau and Scheiner, 2019).

Researchers started investigating car-reduced neighborhoods as far back as the 1990s. In recent years, they have taken a renewed interest in them and their residents in order to investigate possible factors influencing sustainable travel behavior (Baehler, 2019; Baehler and Rérat, 2020a; Baehler and Rérat, 2020b; Basu and Ferreira, 2020; Foletta and Henderson, 2016; Sprei et al., 2020). This can be seen in connection with the general interest in the overall potential for 'demotorization' at the individual household level through sustainable urban and transport planning (Aguilera and Cacciari, 2020). Predominantly young people, families, and people with higher education qualifications are residents of car-reduced housing developments (Baehler, 2019; Baehler and Rérat, 2020b; Nobis, 2003; Scheurer, 2001). This shows the potential of car-reduced neighborhoods to encourage car independence, as especially families and people with a higher education and higher income are usually more likely to use motorized transport (Brown, 2017; Johansson et al., 2019; Kühne et al., 2018; Mitra and Saphores, 2017; Villeneuve, 2017). Quantitative (Nobis, 2003; Scheurer, 2001), mixed methods (Baehler, 2019; Johansson et al., 2019) as well as qualitative studies (Sprei et al., 2020) conclude that, compared to the city as a whole, residents of such neighborhoods are significantly more likely to travel by non-motorized, public transport or sharing modes than by a private car. While some residents were already living car-free voluntarily before their residential relocation, others disposed of their private car shortly before the move (Baehler, 2019) or after moving there, and, then again, others keep their car (Baehler, 2019; Nobis, 2003; Scheurer, 2001; Selzer, 2021). However, car ownership in this type of neighborhood is below the city average (Baehler, 2019; Nobis, 2003; Scheurer, 2001). Baehler (2019) concludes that not only do people move in who were

already living car-free, but that relocating into such a residential area can be a 'key event' for giving up car ownership. Baehler and Rérat (2020a) show that the motivations for living car-free lie between 'personal conviction' and 'practical considerations' with respect to the spatial context, (transport) infrastructure, as well as the residents' travel needs and social context. Similarly, other studies argue that the decision to live a car-free life voluntarily is driven by a combination of choices, constraints, and attitudinal changes toward car ownership (Lagrell et al., 2018; Sattlegger and Rau, 2016; Villeneuve, 2017).

To date, most studies on car-reduced neighborhoods have followed the discussion on the effect of spatio-structural factors or individual and socio-cultural factors on travel behavior, reflecting the existing division in travel behavior research into *individual agency* and *structure* (Heisserer and Rau, 2017; Rau and Sattlegger, 2018) as determinants of residents' mobility. On the one hand, residents' travel behavior and car ownership level are influenced by their residential context and (transport) infrastructure: density, land-use diversity, a good walking and cycling infrastructure and public transport access, as well as the availability of sharing services supporting the use of sustainable transport modes (Borgers et al., 2008; Da Silva Borges and Goldner, 2015; Melia, 2014; Melia et al., 2010; Ornetzeder et al., 2008). Car-related costs (e.g. metering on-street parking) and parking restrictions (e.g. reducing the residential parking supply usually required by planning and construction law) decrease the level of car ownership and car use (Aditjandra et al., 2012; Christiansen et al., 2017; Guo, 2013; Kirschner and Lanzendorf, 2019). On the other hand, individual and socio-cultural factors, such as the transition to a new life stage or a job change, which e.g. coincide with the residential relocation to a car-reduced neighborhood, also have an influence (Johansson et al., 2019). Further, personal preferences regarding transport mode use or household motivations for living car-free already affect travel behavior and car ownership before the residential relocation (Baehler and Rérat, 2020b; Melia, 2014; Nobis, 2003; Scheurer, 2001; Sprei et al., 2020).

2.2. Social practice theory in transport studies: 'Mobility as a practice'

Shove (2010) suggests analyzing mobility as a social practice in order to take the 'context of (travel) behavior' into account. In this perspective, a practice is defined as "a temporally and spatially dispersed nexus of doings and sayings" (Schatzki, 2002, p. 71) and a knowledge-based behavioral routine (Reckwitz, 2002), reproduced and changed through daily enactment by 'practitioners' (Shove et al., 2012). A key difference between practice-theoretical and behavioral research is that the former focuses on *practices* rather than *individuals and their behavior* (ibid.). Table 1 shows further differences between practice theory in transport studies and travel behavior research (including mobility biography research), e.g. in terms of their ontology, methodology, analytical power or substantive concern.

Based on Schatzki and Reckwitz, Shove et al. (2012, p. 24) propose that "practices are defined by interdependent relations between materials, competences and meanings" (Figure 1). They understand *materials* as "objects, infrastructures, tools, hardware and the body itself" (ibid., p. 23). Shove (2017) distinguishes between infrastructural (e.g. streets), device-oriented (e.g. car), and resource-based materials (e.g. fuel). *Competences* cover "skill[s], know-how and technique[s]" (Shove et al., 2012, p. 14) that are crucial for practice performance. *Meanings* "represent the social and symbolic significance of participation at any one moment", including "emotion and motivational knowledge" (ibid., p. 23). To analyze the emotions and feelings related to mobility practices, we follow McCormack (2008, p. 1824), who highlights "affectivity [a]s an important part of spatial experience" and, thus, proposes the following conceptual distinction: "Affect is a kind of vague yet intense atmosphere; feeling is that atmosphere felt in a body; and emotion is that felt intensity articulated as an emotion" (ibid., p. 1827). This is in turn shaped by socially constructed meanings as defined by Shove et al. (2012). Hampton (2017) provides a connecting point to examine

Table 1

Points of difference between travel behavior research and social practice theory in transport studies (based on Reid and Ellsworth-Krebs (2019), Schwanen (2015), and Shove et al. (2012, pp. 143-146)).

	Travel behavior research	Social practice theory in transport studies
Disciplinary origin	Economics, psychology, engineering, time geography	Sociology, science and technology studies, cultural geography, new mobilities paradigm
Ontology	'Behavioralist/Structuralist'	'Poststructuralist'
Methodology	Predominantly quantitative methods	Mostly qualitative approaches
Analytical performance	'Predictive'	'Explanatory'
Substantive concern	Individual travel behavior (e. g. after moving to a car-reduced housing development)	Everyday practices of mobility (e.g. from a car-reduced neighborhood)
Focus of analysis	'Individual and his/her behavior', as a result of choice and decisions based on personal preferences, attitudes, beliefs, needs, and constraints	Practices as 'routinized nexus of doings and sayings', integrating 'materials', 'competences', and 'meanings'
Individual's role	'Driver of behavior'	'Carrier' of a practice (Shove et al., 2012, p. 7)
Drivers of change	Individual (rational) choice, influenced by 'social norms' or 'context'	'Shared, social convention' (practical knowledge, meanings, and competences)
Process change concept	'Causal'; impact of 'key events' on travel behavior (see mobility biography approach, e.g. Müggenburg et al., 2015)	'Emergent'; incremental changes in (mobility) practices (Rau and Manton, 2016; Rau and Sattlegger, 2018)
Policy targets	"External influence on the factors and drivers of behavior" (Shove et al., 2012, p. 143)	"Embedded in the systems of practice it seeks to influence" (Shove et al., 2012, p. 143)

affective experiences and satisfaction with (mobility) practices.

Recently, more and more transport studies have been working with social practice theory to understand the dynamics of everyday mobility (Kent, 2021) and to explore ways of moving beyond 'car hegemony' (Haas, 2020) and toward sustainability in daily travel (Shove and Walker, 2010). To gain a deeper understanding of the transformation potential toward pro-environmental (Hards, 2012) or decarbonized mobility practices (Watson, 2012), a practice-theoretical approach is increasingly being pursued. Kent and Dowling (2013), Kent and Dowling (2018), Svennevik et al. (2020), as well as Julsrud and Farstad (2020) study car sharing practices. Johansson et al. (2019) and Breadsell and Morrison (2020) investigate changes in mobility practices after moving to a car-reduced neighborhood. Laakso (2017) and Hesselgren and Hasselqvist (2016) study changes in mobility routines after giving up a privately owned car as an experiment. Kent (2015), instead, focusses on the emotions and feelings related to the car that contribute to sustaining car driving. Cass and Faulconbridge (2017) analyze experiential and affective meanings of everyday mobility generated by incorporated practices that lead to mobility performance satisfaction. Meinherz and Fritz (2021) explore shifts in meanings ascribed to everyday mobility that foster changes toward low-carbon mobility. Research also focuses on different trip purposes, e.g. commuting practices (Cass and Faulconbridge, 2016; Heisserer and Rau, 2017; Meinherz and Binder, 2020).
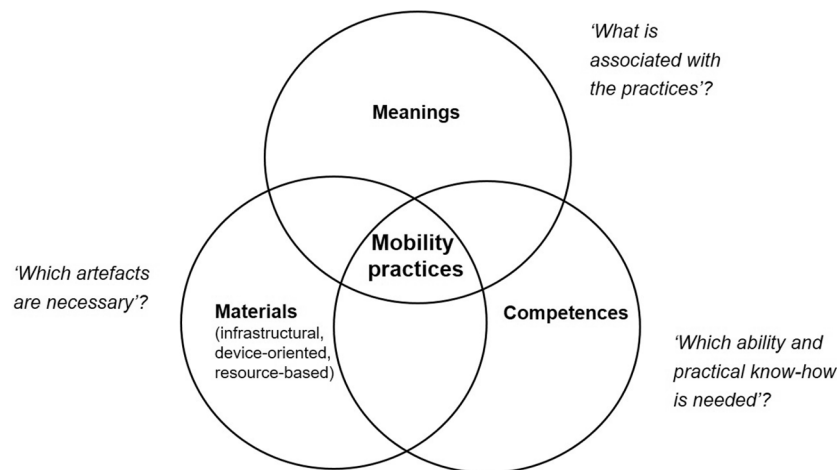
Fig. 1. The element-based approach (own figure based on Shove et al. (2012), Shove (2017) and Reckwitz (2003)).

Lastly, research is carried out on the mobility practices of different groups of people, e.g. well-to-do (middle-/upper-income) households (Aro, 2016) and families with young children (Lagrell et al., 2018; McLaren, 2016). All of these studies prove social practice theory to be an insightful approach to understanding everyday mobility (change) and its complex influencing factors (for a recent review, see Kent, 2021), which this article investigates further.

2.3. Biographically inspired practice-theoretical approach

Besides differences (Table 1), travel behavior research (including mobility biography research) and social practice theory in transport studies share the ambition of advancing the understanding of the potential of the transition to sustainable transport systems (Kent, 2021). Although the use of interdisciplinary approaches provides a potentially more comprehensive view of a study object (Whitmarsh et al., 2011), here mobility from car-reduced neighborhoods, its understanding still remains fragmented, as it predominantly continues to be considered separately by different disciplines (Cairns et al., 2014; Javaid et al., 2019). However, we believe that combining both approaches allows for a better understanding of the complexity of factors shaping mobility (change). This is why we choose a biographically inspired practice-theoretical approach (for similar work, see Greene and Rau (2018) and Rau and Sattlegger (2018)) to study mobility practices from car-reduced neighborhoods.

Primarily, we follow Shove et al.'s (2012) theory of social practice by conceptualizing everyday travel behavior as *mobility practice*. Firstly, this differs from traditional travel behavior research by overcoming the assumption that "what people do is essentially a matter of choice" (ibid., p. 141) and "external variables […] influence individuals' decision making" (Greene and Rau, 2018, p. 63). Human action is instead determined by routinized everyday knowledge and is to be understood as "embodied, material, temporal and spatial organisation" (ibid, p. 65). Instead of focusing on the individual and his or her agency to understand mobility (change), practice theory emphasizes the '(re)production of social-material mobility practices' (Greene and Rau, 2018; Shove et al., 2012) in order to go beyond individualistic interpretations of mobility (Rau and Sattlegger, 2018). Secondly, practice-theoretical approaches also move beyond structuralist understandings of human (travel) behavior by conceding that people can assess the sense behind their actions, although it is not always fully understood or known (Greene and Rau, 2018; Reckwitz, 2003; Shove et al., 2012). Hence, by looking at *mobility practices* it becomes apparent that "the constitution of agents and structures [is] not […] a dualism, but represent[s] a duality" (Giddens 1984, p. 25 quoted from Shove et al., 2012, p. 3). Our study overcomes this dualism that also prevails in research on mobility from

car-reduced neighborhoods (Section 2.1), by "appreciat[ing] the importance of temporally, culturally, spatially and personally contingent reasons for action" (Reid and Ellsworth-Krebs, 2019, p. 301).

However, proponents of this approach discuss the hitherto poorly analyzed relation between individuals and practices. In this regard, Greene and Rau (2018, p. 77) suggest that combining the mobility biography approach with practice theory is beneficial to "rehabilitat[e the] focus on […] subjectivity in practice studies". Further, Hui and Spurling (2013, p. 9) argue "that practices are made up not only by elements, but also of careers". Hence, in order not to neglect the importance of individual lives, the practitioners' mobility biographies also need to be explored (Greene and Rau, 2018; Hui and Spurling, 2013). Thus, to avoid overlooking the role of the 'practice carrier' and to draw on the recognition of residential relocation as a potential disruption of routinized mobility (Müggenburg et al., 2015), our research combines social practice theory with mobility biography research and its temporal focus on the life course (Rau and Sattlegger, 2018). Consequently, considerations not only include the material and social contexts of residents' travel behavior, meanings (including feelings and emotions), as well as temporalities and inter- and path dependencies of 'practice bundles' (e.g. working and mobility; Rau and Sattlegger, 2018), 'direct transport practices' and 'facilitated practices by transport' (Kent, 2021), but also the individual and his/her mobility biography, and 'individual career in a practice' (Greene and Rau, 2018), which equally affect daily mobility (Aro, 2016; Laakso, 2017).

3. Research design

3.1. Case studies

This study is based on two German car-reduced housing developments, both located in the City of Darmstadt (Figure 2), inhabited by 161,620 residents (as of December 2020, Darmstadt City of Science, Department of Economy and Urban Development 2021a): Firstly, the greenfield development K6-Kranichstein (hereafter referred to as K6), completed in 2015 and inhabited since 2003; and, secondly, Lincoln, as a conversion site development still under construction, but already inhabited since 2016. Hence, a different stage of development and a different duration of residence can be assessed by comparing these two neighborhoods.

In K6, approximately 750 housing units were built, mainly as detached houses, but also apartment buildings. In Lincoln, approximately 2,000 housing units are to be built by 2028, mainly as apartment buildings. This implies a higher density compared to K6. In both neighborhoods, emphasis is placed on a social mix and some sites are sold to cooperative home owner groups. However, since most of the
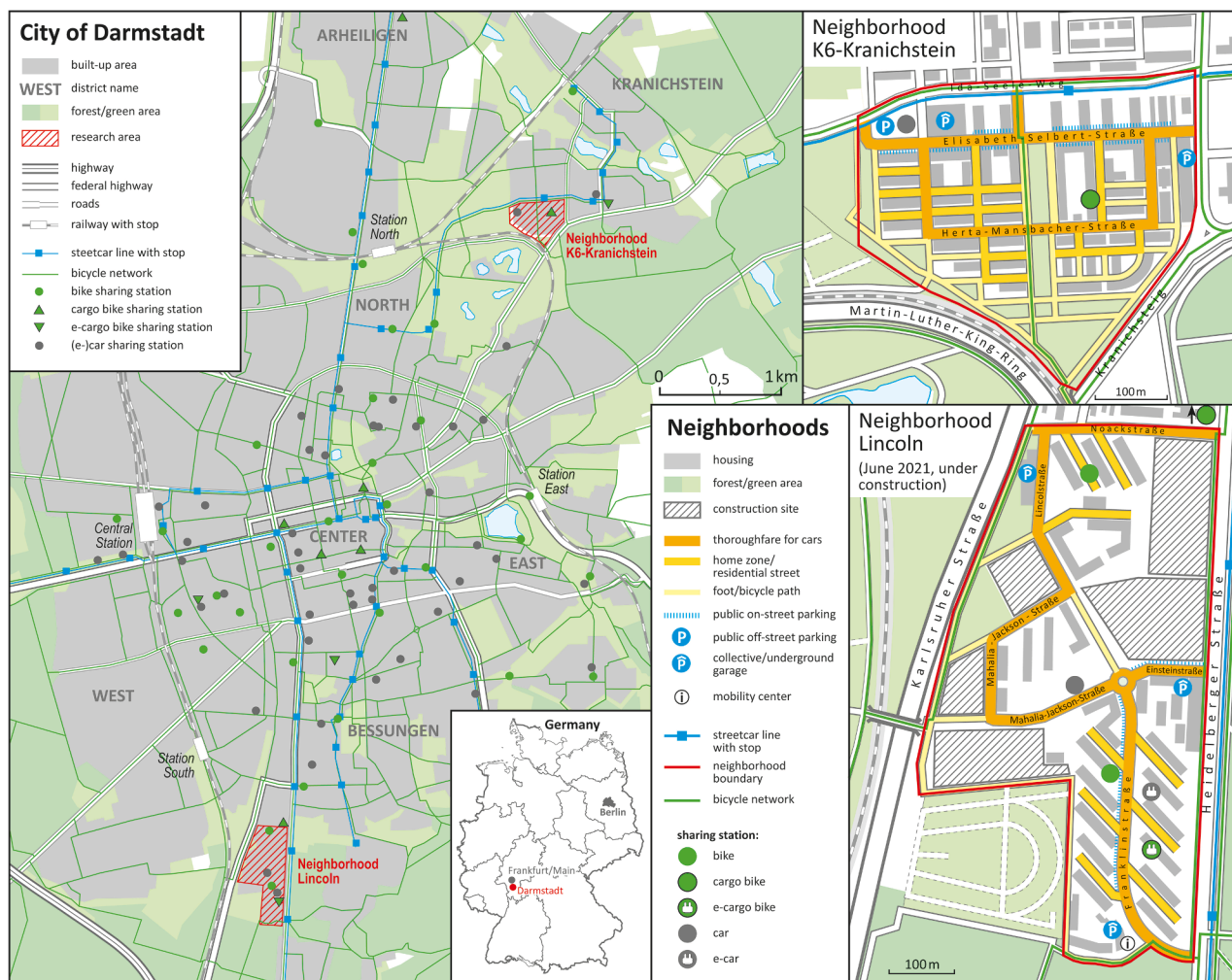
Fig. 2. The City of Darmstadt and the two car-reduced neighborhoods Lincoln and K6 (designed by Elke Alban, Department of Human Geography, Goethe-University Frankfurt/Main).

housing in K6 is owned, it can be concluded that predominantly middle-/upper-income people live there. In contrast, Lincoln has mostly rental housing, resulting in more diverse household types. K6 only has residential buildings, but supermarkets, schools, and kindergartens are within walking distance in the surrounding district of Kranichstein. Lincoln, currently, only has residential buildings, but this is expected to change with the development of a school, a kindergarten, and a supermarket. Today, 1,204 residents live in K6 and 1,850 in Lincoln. Lincoln residents are younger than K6 residents, which can be explained by the different ages of the developments. Nearly half of K6 residents are over 45 years old, compared to only 17% in Lincoln. In Lincoln, about one third are under 18 and, in K6, about one quarter. Both are above the citywide value. Compared to Darmstadt, the household size is also higher. While nearly half of Darmstadt's population lives in a one-person household, Lincoln and K6 have an average of 2.2 people living in each household (as of December 2020, Darmstadt City of Science, Department of Economy and Urban Development 2021b).

Although Lincoln and K6 were developed about 15 years apart from each other, they both pursue the idea of lowering parking supply and calming traffic to decrease private car ownership and car use as well as increase the quality of life for the inhabitants of their respective neighborhood. In order to reduce private car use and car ownership, maximum parking requirements have been set, collective garages have been built, parking spaces must either be purchased (K6) or rented (Lincoln), and on-street parking is metered. This is in contrast to traditional German developments with cost-free parking. In order to

strengthen non-motorized, public, and shared mobility, both settlements are connected to the city center and the main train station of the City of Darmstadt by streetcar lines. The bicycle infrastructure has been continuously improved and a car sharing and cargo bike sharing station is available on each site. Additionally, Lincoln residents are provided with mobility services, like bike sharing, e-cargo bike sharing, e-car sharing (cost-free for four hours per month per household), and a mobility center for personal traveler information (Figure 2).

Both neighborhood's 'car-reduced' planning can be seen in the context of the local government's aim to promote Darmstadt as a sustainable city. K6's development, which began in 1998, was at that time related to the establishment of a Local Agenda 21. Lincoln's development, which began in 2011, is linked to a renewed emphasis on sustainable urban development goals in the context of urban growth; on the one hand, enforced e.g. by a diesel driving ban in Darmstadt, but, on the other hand, also politically promoted by a Green-party mayor and societally demanded. In 2018, Darmstadt residents undertook 35% of their daily trips by car, 18% by public transport, 22% by bicycle, and 25% on foot (Gerike et al., 2019). Compared to the German average, their car use is lower and bicycle use is much higher (Follmer and Gruschwitz, 2019). Thus, Darmstadt appears to provide a material and socio-cultural context that increases the likelihood that car-reduced housing will be accepted. However, car traffic is still dominant in the cityscape, as cars continue to be the most frequently used transport mode for commuting and leisure activities (Gerike et al., 2019).

3.2. Data and method

Despite some critical views on interviews as the method of choice for investigating practices, Hitchings (2012) argues that individuals can talk about their practices. Thus, for this study, we collected 22 qualitative, problem-centered interviews (Witzel and Reiter, 2012) with residents of both neighborhoods (Lincoln: n = 12; K6: n = 10). To recruit potential interviewees, we distributed leaflets in the neighborhoods, posted calls for our project on neighborhood-specific websites and participated in neighborhood events. Then, interested residents volunteered to participate. From these, we drew a selection based on socio-demographic characteristics and theoretical considerations (Kelle and Kluge, 2010). This did not intend to achieve statistical representativeness, but to show heterogeneity in the field of investigation.

We conducted the interviews face to face in fall 2019. The focus was not only on the material and socio-structural contexts of the residents, but also on the personal, social, and temporal aspects of their everyday life and mobility before and after relocating to Lincoln or K6 respectively. The interviews also addressed their relocating motivation, expectations regarding the mobility concept of the new residential location, as well as satisfaction with it. At the end of the interview, we asked the interviewees to complete a questionnaire containing information on socio-demographic, socio-economic, and housing characteristics as well as individuals' and households' mobility tools and equipment (Table 2). All those without a car in their household claim this is voluntary and not e.g. for financial reasons. Income does not generally appear to be a limiting factor in our sample. More than half of our respondents have a medium personal net monthly income (3,000–4,000€). This may also be related to the fact that 77% of our interviewees have a university degree. 42% of our Lincoln respondents, however, have a lower educational attainment. All of our interviewees moved into the neighborhoods when their development was still under construction. For some K6 residents, this meant that streetcar access was not yet available. Likewise, car sharing and cargo bike sharing has only been available for a few years. In both neighborhoods, most interviewees moved in before the collective garages opened and on-street parking was metered. At the time of the interviews, housing and other facilities for daily needs were still being built in Lincoln, but most of the transport infrastructure available today (streetcar access, (e-)car sharing, (cargo) bike sharing) was already in place.

We transcribed the audio-recorded interviews and analyzed them in two steps using a 'thematic qualitative text analysis' in combination with a 'type-building text analysis' (Kuckartz, 2014). For the first step of the analysis, we identified selected thematic aspects and coded the material with regard to the research question. For this purpose, we created both deductive and inductive codes. In the second step of the analysis, by comparing and contrasting the individual narratives of all interviewees on their daily mobility, we identified their different practice performances (Table 3): (i) *public transport use*, (ii) *cycling*, (iii) *cycling/public transport use*, (iv) *walking*, (v) *leisure private car driving*, (vi) *leisure car sharing*, (vii) *private car driving grocery shopping*, (viii) *private car driving commuting*, and (ix) *accompanying children private car driving*. Next, whether or not the car plays a role in the practice led to grouping the practices into (i) *car-independent* and (ii) *car-dependent mobility*.

4. Everyday mobility practices from car-reduced housing developments

To analyze the potential and limitations of demotorization through sustainable urban and transport planning, we focus on the everyday mobility practices from car-reduced housing developments, identified by the interviews with residents. By contrasting the car-independent and car-dependent mobility practices identified, we discovered different compositions of *materials (spatial-infrastructural* and *device-oriented)*, *competences*, and *meanings (including feelings* and *emotions)*. Applying the biographically inspired practice-theoretical approach, we additionally identified different *personal*, *social*, *temporal*, and *socio-structural* circumstances of the residents' mobility practices. Finally, we uncovered 'practice bundles' of mobility with other daily practices, such as (i) *family*, (ii) *working*, (iii) *leisure*, and (iv) *grocery shopping*. Below, we describe the practices' elements, residents' travel behavior circumstances, and 'bundles of practices' that interact with either car-independent (Section 4.1) or car-dependent mobility (Section 4.2). We schematically summarize these in Figure 3.

Although the following presentation of the results is based on statements by the 'carriers' of the car-(in)dependent mobility practices, it is not their individual agency that determines mobility from car-reduced neighborhoods. Their action is rather to be understood as "embodied, material, temporal and spatial organisation" (Greene and Rau, 2018, p. 65). The practices of car-(in)dependent mobility only arise from the integration of all their 'elements', even if they are presented separately one after the other in the following for analytical reasons. Finally, the following presentation of the findings reflects not only the need to understand the everyday mobility of residents in a car-reduced neighborhood in its *context* (Shove, 2010), but also that the role of the 'practitioner' and his/her relation to the mobility practices should be considered to comprehend mobility (Greene and Rau, 2018).

4.1. Car-independent mobility practices

4.1.1. Materials, competences, and meanings of car-independent mobility

A crucial *spatial and infrastructural material* requirement for being car-independently mobile is the accessibility of daily destinations on foot, by bicycle, or public transport. Some residents describe the public transport access of their residential location in particular as "a central pillar" (LwL) because it makes car driving unnecessary:

> *"In a city [...] where public transport works well, where all parts of the city are connected, such things [cars] are simply unnecessary. [...] Really, you don't need a car." (JwL)*

Furthermore, diverse and close opportunities enable the performance of car-independent mobility practices, in particular cycling and walking. Most residents characterize the City of Darmstadt as flat and compact, making it "easy to cycle" (GwL). Car driving is "not necessary for trips within the city" (IwL, MmK) because everything is reachable by bike "in a short distance" (RmK). Thanks to the materiality of the residential location, residents link both cycling and using public transport with the *meaning* of reach and accessibility. Thus, personal travel needs can be satisfied without using a car. Walking, however, is mainly performed as a leisure activity (e.g. walking the dog; NwK) or when having enough time on weekends (e.g. AmL) because it is more time-consuming and distance-dependent (e.g. MmK).

Residents experience the use of public transport as more convenient than car driving if their walking distance to the streetcar stop is just as long or even shorter than to their car parked in the collective garage. However, in Lincoln and K6 only a bicycle can be parked on the doorstep, which makes cycling even more convenient and faster. Thus, some residents associate the *meaning* of speed, time saving, convenience, and flexibility with their bicycle:

> *"I admit it, I'm lazy and that's why my bicycle, which is parked on the doorstep, is a better alternative to shop groceries than to walk to the car, drive it out of the garage to a supermarket, push the groceries back and forth to the parking lot, come back here, unload it, and drive the car back into the garage. That takes three times as long as cycling." (UwK)*

This confirms that the idea of car-reduced neighborhoods with separate parking from housing can have a positive impact on the use of alternative transport modes. The same applies to the provision of alternative mobility services in the immediate living environment. Due to access to a nearby car sharing station, residents who live car-free – either already before or just after their residential relocation – describe

Table 2

Characteristics of the interviewees in Lincoln and K6.

Code	Age	Gender	Household type	Children in the household		Employment status	Occupancy status	Date of move-in	Previous residence	Mobility tools (personal/household)			Mobility equipment	
				Sum	Age					Car ownership	Bicycle ownership	Ownership of other two-wheelers	Public transport season tickets	Car sharing membership
Lincoln (n = 12)														
AmL	28	m	living alone	0	–	working full-time	tenant	06/2019	city in the Rhine-Main region	1/1	1/1	–	monthly ticket	–
BmL	37	m	couple with child	1	2	PhD student and working part-time	tenant	09/2019	Darmstadt	1/1	3/6	racing bike	monthly ticket	x
CmL	49	m	living alone	0	–	working full-time	tenant	06/2019	Darmstadt	0/0	2/2	bicycle trailer	–	x
DmL	44	m	couple with child	1	4	working full-time	tenant	12/2016	Darmstadt	1/1	0/1	–	–	–
EwL	–	f	couple with children	2	14, 16	working part-time	tenant	09/2019	German city	1/2	1/4	–	–	–
FmL	42	m	couple with children	2	1, 3	working full-time	tenant	07/2019	German city	0/0	1/4	bicycle trailer	JobTicket[1]	x
GwL	25	f	flat shares	0	–	student and working part-time	tenant	01/2018	city in the Rhine-Main region	0/1	1/2	–	SemesterTicket[2]	–
HmL	33	m	living alone	0	–	student and working full-time	tenant	09/2019	Darmstadt	0/0	1/1	bicycle trailer	SemesterTicket[2]	–
IwL	32	f	childless couple	0	–	working full-time	tenant	08/2019	Darmstadt	1/1	0/0	–	JobTicket[1]	–
JwL	46	f	living alone	0	–	night-school student and working full-time	tenant	04/2019	Darmstadt	0/0	0/0	shopping trolley	JobTicket[1]	x
KwL	58	f	flat shares	4	5-15	working part-time	cooperative housing tenant	03/2019	Darmstadt	0/0	0/8	–	–	x
LwL	60	f	living alone	0	–	working full-time	tenant	08/2016	rural area in the Rhine-Main region	1/1	0/0	shopping trolley	JobTicket[1]	–
K6 (n = 10)														
MmK	70	m	childless couple	0	–	retired	cooperative housing tenant	2008	Darmstadt	0/0	2/3	cargo bike	–	–
NwK	46	f	couple with child	1	14	in education and working part-time	owner	2007	Darmstadt	1/2	2/7	cargo bike	–	–
OwK	54	f	single-parent family	5	14-28	working part-time	owner	2003	Darmstadt	1/1	1/6	–	StateTicket Hesse[3]	x
PmK	52	m	couple with child	1	17	working full-time	owner	2007	rural area in the Rhine-Main region	1/1	1/3	–	–	x
QwK	51	f	couple with child	1	15	working part-time	owner	2012	Darmstadt	1/1	1/4	shopping trolley	StateTicket Hesse[3]	–
RmK	52	m	couple with children	2	12, 17	working full-time	owner	2008	city in the Rhine-Main region	1/1	1/5	–	StateTicket Hesse[3], BahnCard[4]	x
SwK	54	f	couple with child	1	18	working part-time	owner	2004	Darmstadt	0/0	3/10	bicycle trailer	StateTicket Hesse[3]	x

Table 2 (*continued*)

Code	Age	Gender	Household type	Children in the household		Employment status	Occupancy status	Date of move-in	Previous residence	Mobility tools (personal/household)			Mobility equipment	
				Sum	Age					Car ownership	Bicycle ownership	Ownership of other two-wheelers	Public transport season tickets	Car sharing membership
TmK	59	m	single-parent family	1	19	working full-time	owner	2010	Darmstadt	0/0	7/8	pedelec, five bicycle trailers, two tricycles	–	x
UwK	47	f	couple with children	4	7-18	working part-time	owner	2003	Darmstadt	1/1	1/8	cargo bike, bicycle trailer	BahnCard[4]	x
VwK	44	f	couple with children	2	12, 14	working part-time	owner	2008	Darmstadt	0/0	2/6	bicycle trailer, two tandem bicycles	JobTicket[1]	x

[1] The 'JobTicket' is a public transport season ticket linked to employment contracts and conditions of service.
[2] The 'SemesterTicket' is a public transport season ticket provided for students at most colleges and universities in Hesse, Germany.
[3] The 'StateTicket Hesse' is a job ticket provided by the state authorities of Hesse, Germany, for its employees.
[4] The 'BahnCard' is a discount ticket for train rides.

Table 3
Car-independent and car-dependent mobility practices of Lincoln and K6 residents.

Car-independent mobility practices	Number of respondents	Interview cases: 1st row = Lincoln cases, 2nd row = K6 cases
Public transport use practice	18	AmL, BmL, CmL, FmL, GwL, HmL, IwL, JwL, LwL NwK, OwK, PmK, QwK, RmK, SwK, TmK, UwK, VwK
Cycling practice	15	AmL, BmL, CmL, FmL GwL, HmL MmK, OwK, PmK, QwK, RmK, SwK, TmK, UwK, VwK
Cycling/public transport use practice	6	BmL, GwL, HmL OwK, SwK, VwK
Walking practice	12	AmL, BmL, CmL, GwL, IwL, JwL, KwL, LwL MmK, NwK, PmK, RmK

Car-dependent mobility practices	Number of respondents	Interview cases: 1st row = Lincoln cases, 2nd row = K6 cases
Leisure private car driving practice	13	AmL, BmL, DmL, EwL, GwL, IwL, LwL NwK, OwK, PmK, QwK, RmK, Uwk
Leisure car sharing practice	6	CmL, FmL, KwL SwK, TmK, VwK
Private car driving grocery shopping practice	11	AmL, BmL, DmL, EwL, GwL, IwL, LwL NwK, PmK, QwK, RmK
Private car driving commuting practice	4	BmL, DmL, EwL NwK
Accompanying children private car driving practice	4	BmL, DmL, EwL NwK

car ownership as "complete nonsense" (SwK), since they see "no need" (CmL, HmL, JwL, MmK, TmK, VwK). Instead, they discover car sharing as "a wonderful substitute" (VwK) and a "practical" (CmL) and "cost-effective" (SwK) alternative. Most importantly, they describe car-free living as a benefit:

> "Nobody, who has to finance a car, has this flexibility. [...] Instead, we are completely free [in our transport mode choice]." (SwK)

Besides those spatial and infrastructural materials, car-independent mobility practices only recruit residents with personal or household access to *device-oriented materials* other than a car (e.g. a bicycle for cycling). If different bicycle models (pedelec, tricycle, tandem, racing bike) or more than one bicycle are part of their personal or household mobility tool set, residents cycle for different mobility purposes because they are convinced of its *meaning* as a cheaper, more active, and healthier mode of transport. In addition, cycling offers temporal and spatial flexibility, thus creating "a feeling of self-efficacy and freedom" (TmK). The *meaning* of flexibility is therefore not associated with the car, but with the bicycle. If residents acquire the right equipment (rain gear, weatherproof clothing), they cycle in all kinds of weather. The same applies to carrying children or groceries by bike (cargo bike, bicycle trailer, panniers, child bike seat). Cycling is subsequently associated with the *meaning* of weather and capacity independence:

> "Panniers, a basket or a bicycle trailer, whatever, you can carry groceries for a family of six." (UwK)
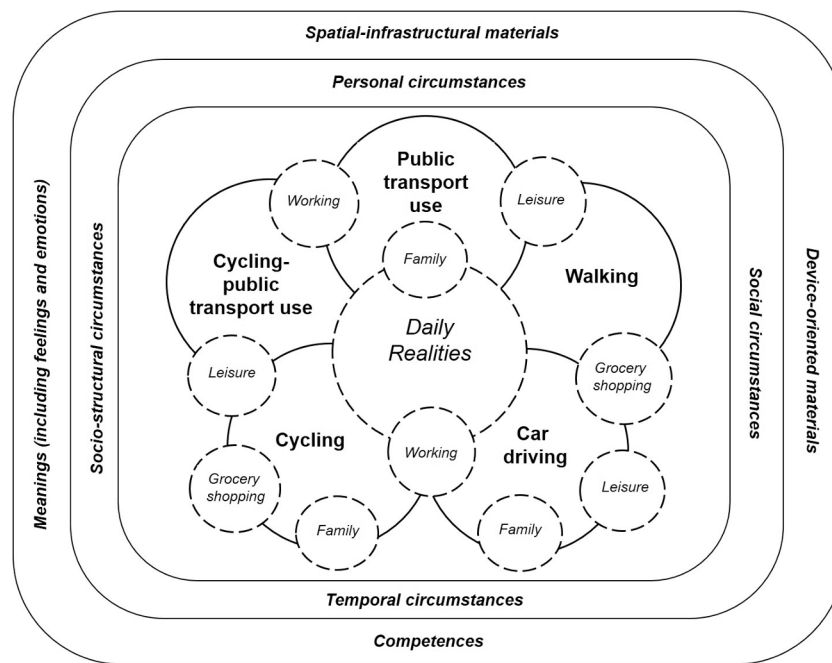
Fig. 3. Schematic illustration of the 'context' of everyday mobility (own illustration).

If residents own neither a private car nor a personal bicycle but have access to a shopping trolley, they carry groceries from their nearby supermarket on foot (e.g. LwL). The lack of access to personal mobility tools or equipment also forces the need for public transport to stay mobile at all:

"I don't have a car or a bicycle. […] What do I have? There is nothing else. But, I mean, that's why we have public transport." (LwL)

If a public transport season ticket is part of their personal mobility equipment, residents frequently use public transport because, first, they describe it as less expensive than car driving:

"Since we have the StateTicket [Hesse], we have reduced our car sharing use. Sure, this is a cost factor. If you can have something for free, you accept some inconvenience." (SwK)

Second, if someone with a season ticket commutes to another city, he or she experiences the combination of cycling and public transport use as a "faster option to get to work" (HmL).

One *competence* that is needed in any case to perform car-independent mobility practices is the ability to organize mobility "differently than by car" (MmK). This means a "higher effort" (KwL, UwK) and, moreover, requires a "greater flexibility" (AmL, VwK). To use public transport, the ability to read timetables, buy the right ticket, and plan a journey in the local public transport network are necessary competences. Non-motorized modes require competences like spatial orientation and local knowledge for routing "to take the safer and faster route" (TmK), physical ability, health, and the ability of "keeping calm in urban chaos" (IwL). Cyclists need some basic riding skills and the knowledge of traffic rules. Furthermore, residents who perform car-independent mobility practices claim to know "the real costs of car driving" (UwK) and are familiar with sustainability discourses. For example, they state that cars should only be used "in a pro human and thoughtful way" (KwL) because they "congest the city" (LwL, RmK, UwK) and "endanger" (FmL, IwL, TmK) cyclists and pedestrians. They call cars space-consuming "sheet metal" (MmK, PmK, TmK) that is "harmful to the living environment" (AmL, OwK, PmK, TmK) and "waste [s] space that could be used differently" (FmL, MmK, PmK, RmK, VwK). For all these reasons, "one must lead by example and support the transport turnaround" (BmL). This exemplifies a strong will, which, on

the one hand, is characterized by ecological conviction, but, on the other hand, also expresses the desire to show 'others' that it is possible to live and be mobile without a car. Driving a car is associated with the *meaning* of being harmful to the environment and people. Thus, public transport is used instead of the car because it is more environmentally friendly. However, cycling is the favorable mode of transport because it is emission-free and, thus, more city-friendly. While this 'willingness' is supportive, it also depends e.g. on the availability of alternatives to the private car. Thus, car-independent mobility only becomes a lived practice through the integration of the materials, competences, and meanings described in this section.

4.1.2. Personal, social, temporal, and socio-structural circumstances shaping car-independent mobility

By looking at the relationship between the individuals and their mobility practices, it is noticeable that certain *personal* and *social circumstances* of the residents' travel behavior, combined with *temporal aspects* related to *family practices* and *working practices*, also shape car-independent mobility practices. Older people seem to reject cycling and car driving more frequently. Instead, they indicate public transport as the "better option" (LwL). Thus, proximity to a streetcar stop is "particularly important in order to remain mobile" (LwL) for seniors. Residents who lack car driving skills or who developed a fear of car driving over their life courses "feel insecure" (GwL) and, therefore, "avoid [car driving] when possible" (QwK). In contrast, they express greater confidence in cycling or taking public transport, resulting in using these transport modes rather than a car. Others have had negative experiences with car driving over their lives – up to "an overdose of car driving" (PmK). This personal history in the practice of car driving is one factor for the move to Lincoln or K6 in order to avoid commuting by car (e.g. AmL, LwL, PmK, RmK):

"Whereas before I had to commute to work in Darmstadt by car every day, [since relocating to K6] I can be out and about by bike, public transport, and on foot." (PmK)

Thus, some residents self-select to Lincoln and K6 to use their preferred environmentally friendly transport mode for daily commuting or because they were convinced by the car-reduced concept. Others relocate to Lincoln or K6 due to the housing situation in Darmstadt

(housing availability and location). This shows that moving one's place of residence is not a completely free location decision. However, to be car-independently mobile, it seems pivotal that an 'individual career' in car-independent mobility is formed over the life course. Thus, an individual has gained positive experiences of being mobile without a car, learned ease and safety in practice handling, and overcome common existing prejudices, e.g. against cycling:

"It rains much less often than non-cyclists think. They think it's cold, you get wet all the time and you're not serious when you arrive on a bike [and] you can't carry enough. This is all wrong. But sure, you have to experience it yourself." (UwK)

Conversely, if a resident owned a private car and used it frequently in past life phases, "it takes time to wean oneself off using it" (OwK), while in parallel the benefits of car-independent mobility practices "have been experienced personally" (OwK):

"In the past, I couldn't have imagined [riding my bike to work every day] […]. I actually never or only irregularly cycled. That has changed completely because I can reach almost everything from K6 so easily." (PmK)

On the one hand, this shows that car driving is more likely to change toward environmentally friendly mobility if its practitioner can build on experience. On the other hand, the longer someone lives in a car-reduced neighborhood, the more likely he or she switches from performing car-dependent to car-independent mobility or even disposes of his/her car.

Residents who are retired (MmK) and live alone (AmL, CmL, HmL, IwL, JwL, LwL) report less time pressure and, thus, the opportunity to spend more time on mobility:

"The others have appointments and everything has to happen fast. […] Of course it would be faster if I took my car. By public transport, it takes me an hour to get to [area]. But I have time, nobody is waiting for me at home. […] I have fewer obligations and I can manage my time freely." (LwL)

Instead, living in a household with children involves "more life struggle" (OwK) and, thus, less available time. However, parents in both neighborhoods whose daily commuting takes place within the same city where they live organize their everyday life and combine work and family without a car, but only with a greater expenditure of time and effort:

"It's just like this: I go out of the house, I put my two children in the bicycle trailer, cycle them to the day-care center and then to work. It takes me probably 15 minutes more. […] But I mean, you have the logistics with two children anyway: Who takes them to the day-care center, how we organize our two jobs, who does the grocery shopping. You have that with or without a car." (FmL)

Thus, in our study, although many households with children use their car more often than childless households, some also claim to deliberately take more time in order to travel by alternative transport modes.

Different social networks also shape car-independent mobility practices. For instance, having a partner who cycles can be supportive for training cycling skills:

"I always argued that you cannot cycle in [area]. Until my husband moved in with me. He just sat down on his bike and then I sat down on mine as well, and realized that it is possible." (UwK)

Moreover, a Lincoln resident indicates her cooperative housing group as an "environmentally conscious peer group" (KwL) where everyone performs car-independent mobility practices. Likewise, K6 residents describe their neighborly context with "like-minded people" (RmK) as a "supportive atmosphere" (SwK) for car-free living:

"It was very helpful to know people who had already used [car sharing] before us, which finally encouraged us [to sell our car]." (SwK)

Looking at *socio-structural contexts,* it appears that, due to digitalization, working from home is possible. This prevents car-dependent commuting (e.g. HmL). Furthermore, flextime working hours help to avoid rush hour traffic and, thus, crowded streetcars. Residents report this as supportive to commuting by public transport instead of by car (e. g. LwL). The constant increase in car traffic also has an influence because residents associate driving a car with being "stuck in traffic all the time" (CmL, IwL). This is why it is "anything but a pleasure" (MmK) and rather "stressful and unpleasant" (TmK). In contrast, they experience both public transport and cycling as less stressful and faster within the city because you can "pass the traffic jam" (QwK). The *meaning* of less stress in combination with speed and saving time therefore causes the performance of car-independent mobility practices instead of car driving. Furthermore, the current discourse on climate change and the transport turnaround contribute to the development of "a car driving shame" (NwK). Thus, as a result of the "social pressure from the next generation with the Fridays for Future movement" (NwK), the once prevalent "social rigidity toward the car" (OwK) is beginning to crack.

4.2. Car-dependent mobility practices

4.2.1. Materials, competences, and meanings of car-dependent mobility

Although bicycle and public transport accessibility makes car ownership and car driving within the city "increasingly expendable" (AmL), all car owners and car sharing members describe the *spatial and infrastructural material* of the surroundings of Darmstadt as 'car-centric'. Accordingly, the car has its "justification" (AmL, GwL, LwL, TmK) for leisure trips to rural and suburban areas because there is often no or only "unsatisfactory public transport access" (DmL, EwL, IwL, KwL, NwK) and, thus, "no equivalent alternative" (AmL, DmL, EwL, IwL) to the car. Hence, many residents use their car bundled with *leisure practices* because of its association with the *meaning* of having "a greater spatial reach" (OwK, UwK) and "being mobile at any time" (AmL, UwK). They associate with their car "freedom" (DmL), "flexibility" (KwL, IwL, RmK), "spontaneity" (LwL), "convenience" (BmL, EwL, FmL), and, lastly, speed and saving time:

"Some destinations [in rural areas] can only be reached by car without a loss of time." (OwK)

Further, most residents emphasize the lack of mixed land use in Lincoln and K6 as a "weak point" (QwK) of the residential developments because a higher transport effort is required. This in turn poses a greater challenge to being mobile without a car:

"Here [in Lincoln] simply nothing is within walking distance. Only the streetcar stop and that's it. So you have to leave the neighborhood for every purpose. […] I know that I can't have the infrastructure from [area] on my doorstep here. I know that. But the fact that I can't find anything at all is a disaster." (FmL)

However, proximity is experienced differently and seems to be connected with different feelings of convenience. Some residents argue that only the car is suitable for carrying groceries because there is no supermarket located within walking distance (e.g. AmL, DmL, EwL, IwL, QwK). Others report that shopping for groceries is often done by car "for practical reasons and habit" (GwL, NwK, PmK), even though there is a supermarket "nearby" (PmK). *Grocery shopping practices* could be done on foot or by bicycle, but they are done by car for "convenience" (BmL, LwL, RmK). Furthermore, some residents integrate grocery shopping into their car-dependent commute.

All car owners designate the greater capacity independence of their car as *device-oriented material* compared to walking or cycling and, therefore, practice at least bulk shopping by car. The car is characterized as "the only convenient option" (DmL) to carry many and heavy items.

Since you do not have to carry the purchases yourself, it is more pleasant. However, residents who additionally own a cargo bike or a bicycle trailer perform only occasional bulk shopping by car, as they cycle for minor grocery purchases in order, as they put it, to deliberately keep car trips to a minimum (e.g. BmL, LwL). If residents only own a private car, they use it regardless of the destination or the purpose of the trip (e.g. DmL) because of its association with the *meaning* of being faster, more convenient, cheaper, safer, and more weatherproof compared to all other transport modes:

> *"There are no mobility services [in Lincoln] that could replace my own car." (DmL)*

Residents without a public transport season ticket commute by car, as they experience public transport as more expensive than car driving:

> *"I used to commute to work by car […] because I had to pay five euro for a day ticket each time. But now [since I got the StateTicket Hesse], I don't commute by car anymore." (QwK)*

In contrast to car-independent mobility practices, none of the residents mention any specific *competences* for driving a car. Thus, all car owners and car sharing members experience its use as obvious and "familiar" (EwL), although they had to acquire driving know-how with the acquisition of a driver's license first. This illustrates that much less thought is given to car driving because most people have incorporated it into the practice of their everyday life and almost all have a long personal history with the car driving practice. This is discussed in more detail below.

4.2.2. Personal, social, temporal, and socio-structural circumstances shaping car-dependent mobility

By looking at the relationship between the individuals and their mobility practices, it is noticeable that certain *personal* and *social circumstances* of the residents' travel behavior, combined with *temporal aspects* related to *family practices* and *working practices*, also shape car-dependent mobility practices. Residents (i) whose workplace is in a different city than their place of residence, (ii) who work in the field and travel to different places outside the City of Darmstadt, or (iii) who practice shift work in the manufacturing sector commute by car. Firstly, this is because they experience car driving as the "most convenient and most cost-effective way to reach the workplace" (DmL). Secondly, they designate it as faster due to the inflexibility of public transport (e.g. EwL). Thirdly, due to the time saved, "parental duties can be better combined with work" (BmL). Thus, driving a car "is not a passion" but rather "a means to an end" (NwK) that "helps to ease the burden of everyday life" (DmL). They characterize their car as an "object of utility" (OwK, PmK, QwK, RmK, UwK), which allows them to combine other practices on the way to their workplace:

> *"By car I save time on so many routes. […] It's a tough calculation: By car, I can manage to be only 25 minutes late, […] to get to work myself, with a stopover at the kindergarten and at my wife's workplace. By public transport, 45 minutes." (DmL)*

Many residents describe the organization of everyday life with children as easier if they can use a private car instead of cycling or using public transport. Also, car sharing requires "greater flexibility, organizational and planning know-how compared to driving a private car" (BmL). Thus, they associate car ownership and car driving with the *meaning* of relieving the burden of organizing daily family life. Consequently, according to some residents, car-free living is out of the question. In some cases, for instance, childbirth triggered the purchase of a private car:

> *"[W]e bought a car again after a long time. We've actually been practicing car sharing for years, but with a child car sharing becomes rather impractical, […] so it [the purchase] was more for convenience reasons.*

> *Especially because part of our family lives on the outskirts and we often travel there on weekends." (BmL)*

Some residents report that as their children grow older and are more autonomously mobile, motorized accompanying trips do not take place anymore (e.g. OwK, UwK). But when travelling with younger children (e.g. BmL, FmL), they describe car driving as a more convenient and comfortable, more capacity-independent, more flexible, and faster alternative. The car offers "relief" and is therefore called a "luxury good" (BmL, OwK). In contrast, they experience public transport use or cycling as "less safe" (EwL), especially in darkness, and "less convenient for longer distance travelling" (BmL).

Car-centric urban and transport planning can be mentioned as a *socio-structural context* for car dependence. It remains effective and constitutes a strong challenge for the planning ideal of car-reduced neighborhoods, since even people who, as they themselves say, voluntarily live without a private car report that "without a car I cannot be as mobile as I want to be in some situations" (KwL) and, thus, perform leisure car sharing:

> *"Maybe once every two weeks we rent a car, […] because the surroundings are more easily accessible by car. […] My parents live near [area]. Okay, we take the streetcar to the main station, then we take the train to [area], then we get on the bus to reach the neighboring town and then we walk. Two hours. So, for an afternoon visit with children, that doesn't work. By car, half an hour." (FmL)*

Furthermore, employment structures in today's society are also factors that shape car dependency and encourage commuting by car:

> *"Wherever a shift worker has to travel, accessibility by public transport is poor. I wouldn't know which bus leaves at five in the morning to the outskirts of Darmstadt. […] It [the mobility concept of Lincoln] is nice on paper, […] but I don't see how anyone who works in the manufacturing sector can stick to it [being mobile without a car]. I think that is out of the question." (DmL)*

Due to functional urban planning and the separation of living and working, commuting distances are too long to be covered on foot or by bike for some residents (e.g. EwL, NwK). As "the companies are not located in the city center, but far away, outside the city or on the outskirts" (DmL), distance and accessibility appear to be decisive factors for commuting by car.

5. Discussion: Feasibility of car independence?

The everyday mobility practices of residents in car-reduced neighborhoods differ along a spectrum of car (in)dependency and multimodality, confirming both the potential and limitations of such housing developments. These, in turn, reflect both the feasibility of car independence as well as automobile dependency.

On the one hand, our findings confirm the residential location as a factor influencing everyday mobility (Heisserer and Rau, 2017). As non-motorized, public, and shared transport modes are politically and materially supported in car-reduced neighborhoods, the residential location undermines the position of the automobile. Thus, car-reduced neighborhoods provide a 'viable practice space' and 'access to material elements' (Shove et al., 2012) necessary for car-independent mobility, whereby car-independent mobility practices are stabilized and supported (Johansson et al., 2019). Restrictive transport policy measures, such as separating parking from housing, also show positive effects on car independence. Although the extent cannot be conclusively assessed with this study, car-reduced neighborhoods have – due to their material context (including restrictive and incentive-based measures) – a higher potential to change people's car-dependent mobility (Baehler, 2019) than conventionally planned car-oriented housing developments. Yet, in our study, the stabilizing effect is even higher because many residents were already multimodal and mobile in a less car-dependent

way at their previous residence. Although relocating to Lincoln and K6 was also driven by factors e.g. related to the housing situation in the City of Darmstadt, a 'residential self-selection' effect is visible. For instance, some residents relocated to Lincoln or K6 to shorten their commute and, thus, no longer have to rely on their cars. So, besides the material context of the residential location, we identify personal-temporal contexts of residents' travel behavior as supporting car-independent mobility practices.

As already mentioned by Schatzki (2001) and Shove et al. (2012, p. 24), "what people do has a history and a setting". Due to their personal experiences with car-independent mobility practices, many residents of car-reduced neighborhoods already associate positive meanings, emotions, and feelings with them; they can fall back on necessary competences; and have access to device-oriented materials (e.g. monthly ticket for public transport, shopping trolley, bicycle trailer, weatherproof clothing). As Cass and Faulconbridge (2016) argue, we also suggest that changes in car-dependent mobility become more anchored after a residential relocation if people had prior experience in walking, cycling, or using public transport. Thus, car-independent mobility practices are performed more frequently if their practitioners have an 'individual career' (Greene and Rau, 2018) already trained in them. This confirms Hui and Spurling (2013) assumption that (mobility) practices are composed of 'elements' and 'practitioners' careers', thus, affecting the performance type.

Some of our respondents show a strong will to live car-free or be mobile car-independently, expressing their desire to make the system beyond the car work. Hence, we follow Kent and Dowling (2018, p. 2) who state that "[t]ransitions away from private car use […] remain, in part, dependent on those 'doing' transition". Those residents being mobile less car-dependently can be seen as the first movers supporting changes toward low-carbon and sustainable urban transport systems (Baehler and Rérat, 2020a; Baehler and Rérat, 2020b). This in turn popularizes the practice of car-independent mobility and, thus, attracts more practitioners. Since a practice, e.g. car driving, only declines if it is abandoned by its practitioners, a practice only endures if it continues to recruit practitioners (Kent, 2021). Residents who are mobile car-independently can support the change described beforehand.

Furthermore, it seems crucial to consider time regarding adopting car-independent mobility practices (Baehler, 2019). From our study, we deduce that with increasing duration of residence in a car-reduced neighborhood, the more likely one is to reject car driving. Thus, "[c]hanges do not happen from one day to another" (Laakso, 2017, p. 139). Rather, over time, new competences must be acquired and new meanings, feelings, and emotions developed with alternative ways of being mobile. Weaning oneself off the car takes time, during which individuals must make their own positive experiences with car-independent alternatives (Hesselgren and Hasselqvist, 2016; Meinherz and Fritz, 2021). In line with recent findings from mobility biography research (Rau and Manton, 2016), we conclude that changes in mobility tend to occur incrementally over time rather than only being triggered by a 'key event', such as residential relocation. Following Sprei et al. (2020), our study illustrates that the causality of changes in mobility in connection with a residential relocation is difficult to assess. According to our findings, we suggest refraining from assuming a causal process of change in the first place, but rather focus on incremental changes in mobility practices.

Moreover, our study shows the positive influence of the socio-cultural contexts of the residents' travel behavior on the performance of car-independent mobility. Recent public discourses on climate change and the need for a low-carbon transport transition have, for instance, already prompted all residents to at least show awareness of unnecessary car trips and sustainable mobility. Thus, our results reveal that, in addition to the material prerequisites for car-independent mobility, Darmstadt and especially its car-reduced neighborhoods offer a socio-cultural context in which car reduction is more positively received than in a society that is much more dependent on the private car.

On the other hand, our results reflect the car-centric material context of rural and suburban surroundings, which challenges the evolvement of car-independent mobility. Thus, so long as spaces are "planned around the car, it is […] difficult to move around in other ways" (Shove et al., 2012, p. 69). Consequently, we argue that car-reduced housing developments in urban areas as stand-alone solutions are not sufficient to encourage a shift away from cars. Instead, alternatives to the car must be provided in an integrated system (Baehler and Rérat, 2020a; Baehler and Rérat, 2020b) "to ensure that everybody has access to pleasurable low-carbon mobilities" (Meinherz and Fritz, 2012, p. 24).

Furthermore, our study proves the influence of 'practice bundles' of mobility with family and working practices (Heisserer and Rau, 2017), as well as mobility with leisure and grocery shopping practices. Our results indicate that the car still has a special status in connection with family practices, which confirms "the socially embedded nature of car use" (Heisserer and Rau, 2017, p. 592). Leisure practices are also often related to car-dependent mobility (Johansson et al., 2019). Working practices in today's society also contribute to the strengthening of car-dependent mobility practices, as the distances between workplaces and homes increase. Time pressure and stress are experienced during the week, which can be seen as a result of 'social acceleration' (Rosa, 2013). Our results are in accordance with findings reported by Cass and Faulconbridge (2016), who conclude that sequencing commuting with other practices creates new spatialities. These in turn increase time pressure and ultimately make car-independent commuting less viable. Thus, our study confirms that mobility "cannot be analysed as a practice in isolation" (Kent, 2021, p. 17). Instead, one can better comprehend transport decision making by looking at the 'facilitated practices' by transport (Kent, 2021), such as obtaining more time for other daily practices.

By taking a closer look at the meanings of car-dependent mobility practices identified, our findings derive three different dimensions that hinder car independence. The first of these is the symbolic and cultural meanings of private car driving (Shove et al., 2012), such as the representation of automobility as a symbol of freedom and flexibility, and as an ideal of speed (Meinherz and Fritz, 2021). The second is the emotions toward private car driving developed through practitioners' affective experiences of it. As Hampton (2017) elaborated for the practice of working from home, driving a private car also incorporates practices of achieving comfort, exercising control, e.g. over time, and performing temporal and spatial flexibility. This entails 'affective satisfaction' with the practice of private car driving and explains 'non-rational behaviors'. This is particularly evident in our study when groceries are purchased by car, even though a supermarket is located within walking distance. Through years of personal experience, driving one's own car triggers emotions, such as sensations of relief or safety, leading to satisfaction that is central to maintaining this mobility performance type (Cass and Faulconbridge, 2017). The third dimension is 'positive bodily sensations', e.g. the feeling of 'effortlessness' and 'comfort' when using a private car, which impedes the use of alternative transport modes (Kent, 2015). Alternative transport modes to the car are only used if greater planning and time effort as well as a loss of flexibility and convenience can be accepted. In contrast, only the car fulfills the desire "to take the easiest way" (ibid., p. 738), which in turn "create[s] resistance to alternative transport" (ibid.).

Nevertheless, our study also confirms shifts in the meanings of car driving. As Meinherz and Fritz (2021) already revealed, our study reinforces that these are related to dynamics in the 'spatio-temporal complexity of everyday life' (e.g. reducing child care duties), emerge from 'changing social representations of mobility' (e.g. questioning car driving due to its socio-ecological consequences), and are driven by 'subjective experiences' (e.g. experiencing cycling as more pleasant compared to car driving in rush-hour traffic). Our study adds to these dynamics those induced by the material (e.g. car parking in a collective garage instead of next to one's housing) and the socio-cultural contexts of the residents' mobility practices in a car-reduced residential location

(e.g. experiencing neighbors as supportive of car-free living). Finally, we agree with Cass and Faulconbridge (2017), Meinherz and Fritz (2021), and Watson (2012) that the transformation of car-dependent mobility practices only occurs when meanings, emotions, and feelings change, and satisfaction is associated with car-independent rather than car-dependent mobility. Consequently, mobility practices consist not only of 'elements' and 'careers' but also "practice elements [are brought together] in ways that are effective and satisfying for the performer" (Cass and Faulconbridge, 2017, p. 100). This in turn endorses the need to also pay attention to the relationship between the 'practice carrier' and (mobility) practices over time (Greene and Rau, 2018; Hui and Spurling, 2013). This work has attempted to do this by applying a biographically inspired practice-theoretical approach.

6. Conclusions

Our analysis of qualitative interviews with residents of two German car-reduced neighborhoods indicates that their mobility practices reveal the important role of *meanings* (including feelings and emotions). These meanings determine whether mobility is performed car-independently or car-dependently. However, these in turn arise in interaction with (i) spatial-infrastructural materials, (ii) device-oriented materials, (iii) competences, (iv) the personal, and (v) social circumstances of the residents' mobility practices, as well as (vi) temporal aspects, and (vii) the socio-structural contexts of the residents' travel behavior. Furthermore, they are also shaped by the intersection of mobility and other daily practices, such as (i) family, (ii) working, (iii) leisure, and (iv) grocery shopping. As Kent (2021, p. 14) summarizes in reference to Heisserer and Rau (2017), our findings reinforce that a practice prevails "when [it] falls within the field of possibility for a large social group inhabiting similar material realities, guided by commonly accepted aspirations and meanings, and equipped with skills simply considered fundamental to the navigation of modern life".

Taking this into account, our study discovers the limitations and potentials of implementing car-reduced neighborhoods and explores the dependence on the automobile, and the feasibility of car independence. On the one hand, beyond car-reduced neighborhoods – and even more sharply in rural and suburban areas than within the city –, car-centric materialities still dominate, hindering car-independent mobility. Furthermore, car driving is still closely linked to the practice of everyday life, whereby car-dependent mobility practices (e.g. leisure trips out of the city) still recruit residents of car-reduced neighborhoods. Changing routinized car driving practices is rather an incremental process that takes time, and the meanings, emotions, and feelings regarding car driving also need to change. These are, in turn, dependent on e.g. the materiality. On the other hand, this materiality in the case of residential car-reduced neighborhoods stabilizes and supports car-independent mobility practices. Many residents predominantly perform car-independent mobility in daily life because they have additionally already gained personal experiences in practice performance and have trained competences over their lives. Thus, car-independent mobility is ascribed positive meanings, feelings, and emotions that are necessary for using alternative transport modes to the car. In addition to these material and personal-temporal contexts, the socio-cultural contexts of residents' mobility practices in car-reduced neighborhoods also support car independence.

The main conclusion that can be drawn is that it is not sufficient to look at the residents' individual travel behavior in order to assess whether car-reduced planning concepts actually show the expected effects. Neither the 'willingness' of the residents (Thomsen and Löfström, 2011) nor the materiality of the residential location alone is the trigger for turning car-independent mobility into a lived practice. As Kent and Dowling (2018, p. 10) state, "[w]illingness is […] both contingent on and supportive of a city with multiple alternatives to private car use." Hence, a transition away from private car use to environmentally friendly mobility requires shifts within the realms of both structure and

agent. Accordingly, we agree with Shove (2010) that the hitherto prevailing view of change needs to be reconsidered on the level of the individual. Reid and Ellsworth-Krebs (2019) have already aptly summarized that practices, not individuals, are to blame for environmental problems. Thus, social change toward car-independent mobility requires not only individuals changing their mobility, but also that planning practice must continue to change in order to provide an environment that enables the evolvement of pleasant and satisfying car-independent mobility practices rather than car-dependent ones (Cairns et al., 2014; Cass and Faulconbridge, 2017; Meinherz and Fritz, 2021; Watson, 2012). Car-reduced neighborhoods and their residents' mobility practices provide such an environment that stabilizes and supports car independence.

By applying a biographically inspired practice-theoretical approach to everyday mobility empirically (see also Greene and Rau, 2018; Rau and Sattlegger, 2018), our study confirms that mobility is not a utilitarian movement from A to B, but is rather closely linked to the materiality, temporalities, knowledge, emotions, and feelings embedded in everyday life routines and a broader social and cultural context (Heisserer and Rau, 2017). With this perspective, it is possible to recognize both the potential for a transition in the context of a residential relocation to a car-reduced neighborhood and incrementally over people's lives. By combining mobility biography research and social practice theory, our study counteracts, on the one hand, the criticism of predominantly travel behavior research of only taking an individualistic view of explaining mobility (change) (Shove et al., 2012) and, on the other hand, the criticism of social practice theory that the 'practice carrier' is viewed too statically (Greene and Rau, 2018; Hui and Spurling, 2013; Reid and Ellsworth-Krebs, 2019).

So, first, our study fulfills the call to examine not only the agent's role and willingness to pursue change, but follows the demand to shift the focus from individuals and structures to the incorporation of both by analyzing *mobility practices* (Kent, 2021). Thus, our study complements the body of research on car-reduced neighborhoods, which so far predominantly reflects the division between individual agency and structure as the focus of analysis for understanding everyday mobility. Structure and agency can instead be understood as a 'dialectic interplay' (Heisserer and Rau, 2017; Rau and Sattlegger, 2018), which is only revealed by understanding mobility as a social practice (Kent, 2021; Shove et al., 2012). A distinct advantage of practice theory in our research field is that it draws attention to minor influences on mobility and looks at the materialities being part of a practice (Kent, 2021). Further, it takes into account the social and cultural context of mobility (Cairns et al., 2014), and, thus, helps to show its intertwining with other areas of social life (Heisserer and Rau, 2017). This broader context is needed "to understand what and why people do what they do" (Reid and Reid and Ellsworth-Krebs, 2019, p. 302). It pinpoints 'facilitated practices' by transport, such as achieving self-efficacy, that may at first glance seem unrelated to a 'direct transport practice' like cycling. However, these practices need to be understood in order to achieve change (Kent, 2021).

Second, our work provides a fruitful contribution to discussions of the role of 'practitioners', their 'practice careers' (Greene and Rau, 2018; Hui and Spurling, 2013), and their experiential and affective satisfaction in mobility determining its performance type (Cass and Faulconbridge, 2017). By using a 'contextual', 'experiential', and 'temporal' approach (Greene and Rau, 2018), our work enhances the understanding of the interaction between residents' lives and mobility practices. Overall, our study pursues a hitherto rarely used perspective on mobility from car-reduced neighborhoods. This not only contributes to a better understanding of the influences of mobility (change), but also unites two disparate theoretical approaches to get closer to the common goal of transport studies generating insights for a transition toward low-carbon mobility (Cairns et al., 2014; Javaid et al., 2019). Complex problems, such as the transition toward a sustainable transport system, can best be addressed by integrating different approaches (Whitmarsh et al., 2011).

Finally, our work offers many starting points for further research. For example, the process of experiencing car-independent mobility among those residents who rely exclusively on their cars could be examined more closely and methodologically differently. Since experiencing positive emotions and feelings with low-carbon transport modes instead of the car seems to be decisive for a change toward car-independent mobility, ethnographic approaches may offer deeper insights into people's affective satisfaction (Cass and Faulconbridge, 2017; Hampton, 2017) with car-(in)dependent mobility. Moreover, while car-independent mobility practices are already widespread among residents of car-reduced neighborhoods, disposing of the private car is rare. This is a major problem in view of the lack of space in cities and needs to be further investigated. In order to quantify the extent of the influence of the material context on residents travel behavior in car-reduced neighborhoods changing from car-dependent to car-independent mobility, a comparison by means of a quantitative survey with a conventionally developed neighborhood could be considered. However, as is usual with practice-theoretical approaches (Shove et al., 2012), the primary value of this study is in explaining rather than predicting mobility (change).

CRediT authorship contribution statement

Sina Selzer: Conceptualization, Methodology, Investigation, Writing – original draft, Writing – review & editing. **Martin Lanzendorf:** Writing – review & editing, Supervision, Project administration, Funding acquisition.

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.

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References

Aditjandra, P.T., Cao, X., Mulley, C., 2012. Understanding neighbourhood design impact on travel behavior: An application of structural equations model to a British metropolitan data. Transp. Res. Part A: Policy Practice 46 (1), 22–32. https://doi.org/10.1016/j.tra.2011.09.001.

Aguilera, A., Cacciari, J., 2020. Living with fewer cars: review and challenges on household demotorization. Transp. Rev. 40 (6), 796–809. https://doi.org/10.1080/01441647.2020.1772405.

Aro, R., 2016. Normality against sustainability – Mobility practices of well-to-do households. Environ. Policy Governance 26, 116–128. https://doi.org/10.1002/eet.1705.

Baehler, D., 2019. Living in a car-free housing development. Motivations and mobility practices of residents in nine developments in Switzerland and Germany. Université de Lausanne. Available online: https://serval.unil.ch/resource/serval:BIB_2053C99A97BC.P001/REF. [Accessed: 25 July 2021].

Baehler, D., Rérat, P., 2020a. Beyond the car. Car-free housing as a laboratory to overcome the "system of automobility". Applied Mobilities. doi:10.1080/23800127.2020.1860513.

Baehler, D., Rérat, P., 2020b. Between ecological convictions and practical considerations – profiles and motivations of residents in car-free housing developments in Germany and Switzerland. Geographica Helvetica 75, 169–181. https://doi.org/10.5194/gh-75-169-2020.

Banister, D., 2011. Cities, mobility and climate change. J. Transp. Geogr. 19, 1538–1546. https://doi.org/10.1016/j.jtrangeo.2011.03.009.

Basu, R., Ferreira, J., 2020. Planning car-lite neighborhoods: Examining long-term impacts of accessibility boots on vehicle ownership. Transp. Res. Part D: Transp. Environ. 86, 102394 https://doi.org/10.1016/j.trd.2020.102394.

Borgers, A., Snellen, D., Poelman, J., Timmermans, H., 2008. Preferences for Car-restrained Residential Areas. J. Urban Design 13 (2), 257–267. https://doi.org/10.1080/13574800801965734.

Breadsell, J.K., Morrison, G.M., 2020. Changes to household practices pre- and post-occupancy in an Australian low-carbon development. Sustainable Production and Consumption 22, 147–161. https://doi.org/10.1016/j.spc.2020.03.001.

Brown, A.E., 2017. Car-less or car-free? Socioeconomic and mobility differences among zero-car households. Transp. Policy 60, 152–159. https://doi.org/10.1016/j.tranpol.2017.09.016.

Buehler, R., Pucher, J., Gerike, R., Götschi, T., 2017. Reducing car dependence in the heart of Europe: lessons from Germany, Austria, and Switzerland. Transp. Rev. 37 (1), 4–28. https://doi.org/10.1080/01441647.2016.1177799.

Cairns, S., Harmer, C., Hopkin, J., Skippon, S., 2014. Sociological perspectives on travel and mobilities: A review. Transp. Res. Part A 63, 107–117. https://doi.org/10.1016/j.tra.2014.01.010.

Camarero, L.A., Olivia, J., 2008. Exploring the Social Face of Urban Mobility: Daily Mobility as Part of the Social Structure in Spain. Int. J. Urban Reg. Res. 32 (2), 344–362. https://doi.org/10.1111/j.1468-2427.2008.00778.x.

Cao, X., Mokhtarian, P.L., Handy, S.L., 2009. Examining the impacts of residential self-selection on travel behaviour: a focus on empirical findings. Transp. Rev. 29 (3), 359–395. https://doi.org/10.1080/01441640802539195.

Cao, X., Xu, Z., Fan, Y., 2010. Exploring the connections among residential location, self-selection, and driving: Propensity score matching with multiple treatments. Transp. Res. Part A 44, 797–805. https://doi.org/10.1016/j.tra.2010.07.010.

Cass, N., Faulconbridge, J., 2016. Commuting practices: New insights into modal shift from theories of social practice. Transp. Policy 45, 1–14. https://doi.org/10.1016/j.tranpol.2015.08.002.

Cass, N., Faulconbridge, J., 2017. Satisfying Everyday Mobility. Mobilities 12 (1), 97–115. https://doi.org/10.1080/17450101.2015.1096083.

Christiansen, P., Engebretsen, Ø., Fearnley, N., Hanssen, J.U., 2017. Parking facilities and the built environment: Impacts of travel behaviour. Transp. Res. Part A 95, 198–206. https://doi.org/10.1016/j.tra.2016.10.025.

Da Silva Borges, B.F., Goldner, L.G., 2015. Implementation of car-free neighbourhoods in medium-sized cities in Brazil, a case study in Florianópolis, Santa Catarina. Int. J. Urban Sustainable Development 7 (2), 183–195. https://doi.org/10.1080/19463138.2015.1036758.

Darmstadt City of Science, Department of Economy and Urban Development, 2021a. Statistical summary report 2020. Available online: https://www.darmstadt.de/fileadmin/Bilder-Rubriken/Standort/Statistik_und_Stadtforschung/Kurzbericht_Jahr-2020-internet.pdf. [Accessed: 25 July 2021].

Darmstadt City of Science, Department of Economy and Urban Development, 2021b. Population of K6-Kranichstein and Lincoln as of December 2020 compared to the Darmstadt average [not publicly accessible].

Dennis, K., Urry, J., 2009. After the Car. Polity Press, Cambridge/Malden.

Döring, L., Albrecht, J., Scheiner, J., Holz-Rau, C., 2014. Mobility biographies in three generations – socialization effects on commute mode choice. Transp. Res. Procedia 1, 165–176. https://doi.org/10.1016/j.trpro.2014.07.017.

Ewing, R., Cervero, R., 2010. Travel and built environment. J. Am. Planning Assoc. 76 (3), 265–294. https://doi.org/10.1080/01944361003766766.

Foletta, N., Henderson, J., 2016. Low Car(bon) Communities?: Inspiring Car-free and Car-lite Urban Futures. Routledge, Abingdon/Oxon/New York.

Follmer, R., Gruschwitz, D., 2019. Mobilität in Deutschland – MiD Kurzreport. [Mobility in Germany – Short Report] Version 4.0, Study by infas, DLR, IVT and infas 360 on behalf of the Federal Ministry of Transport and Digital Infrastructure. Bonn, Berlin. Available online: http://www.mobilitaet-in-deutschland.de/pdf/infas_Mobilitaet_in_Deutschland_2017_Kurzreport.pdf. [Accessed: 25 July 2021].

Freytag, T., Gössling, S., Mössner, R., 2014. Living the green city: Freiburg's Solarsiedlung between narratives and practices of sustainable urban development. Local Environ.: Int. J. Justice Sustainability 19 (6), 644–659. https://doi.org/10.1080/13549839.2013.868872.

Gerike, R., Hubrich, S., Ließke, F., Wittig, S., Wittwer, R., 2019. Mobilität in Städten, SrV 2018. Mobilitätssteckbrief für Darmstadt. Technische Universität Dresden. Dresden.

Greene, M., Rau, H., 2018. Moving across the life course: A biographic approach to researching dynamics of everyday mobility practices. J. Consumer Culture 18 (1), 60–82. https://doi.org/10.1177/1469540516634417.

Guo, Z., 2013. Does residential parking supply affect household car ownership? The case of New York City. J. Transp. Geogr. 26, 18–28. https://doi.org/10.1016/j.jtrangeo.2012.08.006.

Haas, T., 2020. Cracks in the gearbox of car hegemony: struggles over the German Verkehrswende between stability and change. Mobilities. https://doi.org/10.1080/17450101.2020.1817686.

Hampton, S., 2017. An ethnography of energy demand and working from home: Exploring the affective dimensions of social practice in the United Kingdom. Energy Res. Social Sci. 28, 1–10. https://doi.org/10.1016/j.erss.2017.03.012.

Handy, S., Cao, X., Mokharian, P.L., 2005. Correlation or causality between the built environment and travel behavior? Evidence from Northern California. Transp. Res. Part D 10, 427–444. https://doi.org/10.1016/j.trd.2005.05.002.

Hards, S., 2012. Tales of transformation: The potential of a narrative approach to pro-environmental practices. Geoforum 43, 760–771. https://doi.org/10.1016/j.geoforum.2012.01.004.

Heinen, E., van Wee, B., Panter, J., Mackett, R., Ogilvie, D., 2018. Residential self-selection in quasi-experimental studies: An extended conceptualization of the

relationship between the built environment and travel behavior. J. Transp. Land Use 11 (1), 939–959. https://doi.org/10.5198/jtlu.2018.1165.

Heisserer, B., Rau, H., 2017. Capturing the consumption of distance? A practice-theoretical investigation of everyday travel. Journal of Consumer Culture 17 (3), 579–599. https://doi.org/10.1177/1469540515602304.

Hesselgren, M., Hasselqvist, H., 2016. Give car-free life a try: Designing seeds for changed practices. Proceedings of DRS 2016, Design Research Society 50th Anniversary Conference. Brighton, UK, 27-30 June 2016. Design Research Society. Available online: https://static1.squarespace.com/static/55ca3eafe4b05bb65abd54ff/t/5741ff1f62cd9402346fa248/1463942950345/190+Hesselgren.pdf. [Accessed: 25 July 2021].

Hickman, R., Hall, P., Banister, D., 2013. Planning more for sustainable mobility. J. Transp. Geogr. 33, 210–219. https://doi.org/10.1016/j.jtrangeo.2013.07.004.

Hitchings, R., 2012. People can talk about their practices. Area 1, 61–67. https://doi.org/10.1111/j.1475-4762.2011.01060.x.

Holz-Rau, C., Scheiner, J., 2019. Land-use and transport planning – a field of complex cause-impact relationships. Thoughts on transport growth, greenhouse gas emissions and the built environment. Transp. Policy 74, 127–137. https://doi.org/10.1016/j.tranpol.2018.12.004.

Hui, A., Spurling, N., 2013. Career dynamics in social practices: accumulation, concurrent careers and career demographics. Available online: https://nicolaspurling.files.wordpress.com/2014/09/hui-and-spurling-careers-paper-web-1.pdf. [Accessed: 25 July 2021].

Javaid, A., Creutzig, F., Bamberg, S., 2019. Determinants of low-carbon transport mode adoption: systematic review of reviews. Environ. Res. Lett. 15, 103002 https://doi.org/10.1088/1748-9326/aba032.

Jeekel, H., 2013. The Car-dependent Society: A European Perspective. Ashgate, Farnham.

Johansson, F., Henriksson, G., Envall, P., 2019. Moving to private-car-restricted and mobility-served neighborhoods: The unspectacular workings of a progressive mobility plan. Sustainability 11 (22), 6208. https://doi.org/10.3390/su11226208.

Julsrud, T.E., Farstad, E., 2020. Car sharing and transformation in households travel patterns: Insights from emerging proto-practices in Norway. Energy Res. Social Sci. 66, 101497 https://doi.org/10.1016/j.erss.2020.101497.

Kelle, U., Kluge, S., 2010. Vom Einzelfall zum Typus. Fallvergleich und Fallkontrastierung in der qualitativen Sozialforschung, zweite aktualisierte Auflage VS Verlag für Sozialwissenschaften (Qualitative Sozialforschung, 15), Wiesbaden.

Kent, J.L., 2015. Still feeling the car – the role of comfort in sustaining private car use. Mobilities 10 (5), 726–747. https://doi.org/10.1080/17450101.2014.944400.

Kent, J., 2021. The use of practice theory in transport research. Transp. Rev. https://doi.org/10.1080/01441647.2021.1961918.

Kent, J.L., Dowling, B., 2013. Puncturing automobility? Carsharing practices. J. Transp. Geogr. 32, 86–92. https://doi.org/10.1016/j.jtrangeo.2013.08.014.

Kent, J.L., Dowling, R., 2018. Commercial Car Sharing, Complaints and Coping: Does Sharing Need Willingness? Urban Policy and Research 36 (4), 464–475. https://doi.org/10.1080/08111146.2018.1486297.

Kirschner, F., Lanzendorf, M., 2019. Parking management for promoting sustainable transport. A review of existing policies and challenges from a German perspective. Transp. Rev. 40 (1), 54–75. https://doi.org/10.1080/01441647.2019.1666929.

Kuckartz, U., 2014. Qualitative Text Analysis. A Guide to Methods, Practice & Using Software. Sage Publications Ltd, London.

Kühne, K., Mitra, S.K., Saphores, J.-D.-M., 2018. Without a ride in car country – a comparison of carless households in Germany and California. Transp. Res. Part A: Policy Practice 109, 24–40. https://doi.org/10.1016/j.tra.2018.01.021.

Laakso, S., 2017. Giving up cars – the impact of a mobility experiment on carbon emissions and everyday routines. J. Cleaner Prod. 169, 135–142. https://doi.org/10.1016/j.jclepro.2017.03.035.

Lagrell, E., Thulin, E., Vilhelmson, B., 2018. Accessibility strategies beyond the private car: A study of voluntarily carless families with young children in Gothenburg. J. Transp. Geogr. 72, 218–227. https://doi.org/10.1016/j.jtrangeo.2018.09.002.

Lanzendorf, M., 2003. Mobility biographies. A new perspective for understanding travel behaviour. 10th International Conference on Travel Behaviour Research. Lucerne, 10th-15th August. Lucerne.

Lanzendorf, M., 2010. Key events and their effect on mobility biographies: The case of Childbirth. Int. J. Sustainable Transp. 4 (5), 272–292. https://doi.org/10.1080/15568310903145188.

Lin, T., Wand, D., Guan, X., 2017. The built environment, travel attitude, and travel behavior: Residential self-selection or residential determination? J. Transp. Geogr. 65, 111–122. https://doi.org/10.1016/j.jtrangeo.2017.10.004.

Manderscheid, K., 2014. Formierung und Wandel hegemonialer Mobilitätsdispositive. Automobile Subjekte und urbane Nomaden. Zeitschrift für Diskursforschung 1, 5–31. https://doi.org/10.3262/ZFD1401005.

McCormack, D.P., 2008. Geographies for Moving Bodies: Thinking, Dancing, Spaces. Geography Compass 2 (6), 1822–1836. https://doi.org/10.1111/j.1749-8198.2008.00159.x.

McLaren, A.T., 2016. Families and transportation: Moving towards multimodality and altermobility? J. Transp. Geogr. 51, 218–225. https://doi.org/10.1016/j.jtrangeo.2016.01.006.

Meinherz, F., Binder, C.R., 2020. The dynamics of modal shifts in (sub)urban commuting: An empirical analysis based on practice theories. J. Transp. Geogr. 86, 102763 https://doi.org/10.1016/j.jtrangeo.2020.102763.

Meinherz, F., Fritz, L., 2021. 'Ecological concerns weren't the main reasons why I took the bus, that association only came afterwards': on shifts in meanings of everyday mobility. Mobilities 1–18. https://doi.org/10.1080/17450101.2021.1919491.

Melia, S., 2014. Carfree and low-car development, in: Ison, S., Mulley, C. (Eds.), Parking issues and policies. Transport and Sustainability (Volume 5), Emerald, Bingley, pp. 213-233.

Melia, S., Parkhurst, G., Barton, H., 2010. Car-free, low car – what's the difference? World Transport Policy Practice 16, 24-32. Available online: http://www.eco-logica.co.uk/pdf/wtpp16.2.pdf. [Accessed: 25 July 2021].

Mitra, S.K., Saphores, J.-D.-M., 2017. Carless in California: Green choice or misery? J. Transp. Geogr. 65, 1–12. https://doi.org/10.1016/j.jtrangeo.2017.09.016.

Mokhtarian, P.L., Cao, X., 2008. Examining the impacts of residential self-selection on travel behavior: a focus on methodologies. Transp. Res. Part B: Methodological 42, 204–228. https://doi.org/10.1080/01441640802539195.

Müggenburg, H., Busch-Geertsema, A., Lanzendorf, M., 2015. Mobility biographies: A review of achievements and challenges of the mobility biographies approach and a framework for further research. J. Transport Geography 46, 151–163. https://doi.org/10.1016/j.jtrangeo.2015.06.004.

Næss, P., 2009. Residential self-selection and appropriate control variables in land use: travel studies. Transp. Rev. 29 (3), 293–324. https://doi.org/10.1080/01441640802710812.

Næss, P., 2015. Built environment, causality and travel. Transp. Rev. 35 (3), 275–291. https://doi.org/10.1080/01441647.2015.1017751.

Nieuwenhuijsen, M.J., 2020. Urban and transport planning pathways to carbon neutral, liveable and healthy cities. A review of the current evidence. Environ. Int. 140, 105661 https://doi.org/10.1016/j.envint.2020.105661.

Nieuwenhuijsen, M.J., Khreis, H., 2016. Car free cities: Pathway to healthy urban living. Environ. Int. 94, 251–262. https://doi.org/10.1016/j.envint.2016.05.032.

Nobis, C., 2003. The impact of car-free housing districts on mobility behaviour – case study, in: Beriatos, E., Brebbia, C. A., Coccossis, H., Kungolos, A. G. (Eds.), Sustainable Planning and Development – WIT Transactions on Ecology and the Environment. WIT Press, Southampton, Volume 67, pp. 701-710. Available online: https://www.witpress.com/elibrary/wit-transactions-on-ecology-and-the-environment/67/1979. [Accessed: 25 July 2021].

Oostendorp, R., Oehlert, J., Heldt, B., 2019. Mobilitätsangebote in Wohnquartieren – Erfahrungen und Bewertungen aus Sicht von öffentlicher Verwaltung, Wohnungsunternehmen und Planungspraxis – Ergebnisse einer Expertenbefragung. Arbeitsberichte zur Verkehrsforschung Nr. 2 (2019), Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Institut für Verkehrsforschung, Berlin.

Ornetzeder, M., Hertwich, E.G., Hubacek, K., Kortytarova, K., Haas, W., 2008. The environmental effect of car-free housing: a case in Vienna. Ecol. Econ. 65, 516–530. https://doi.org/10.1016/j.ecolecon.2007.07.022.

Rau, H., Manton, R., 2016. Life events and mobility milestones: advances in mobility biography theory and research. J. Transp. Geography 52, 51–60. https://doi.org/10.1016/j.jtrangeo.2016.02.010.

Rau, H., Sattlegger, L., 2018. Shared journeys, linked lives: a relational-biographical approach to mobility practices. Mobilities 13 (1), 45–63. https://doi.org/10.1080/17450101.2017.1300453.

Reckwitz, A., 2002. Towards a Theory of Social Practices. A Development in Culturalist Theorizing. Eur. J. Social Theory 5 (2), 243–263. https://doi.org/10.1177/13684310222225432.

Reckwitz, A., 2003. Grundelemente einer Theorie sozialer Praktiken. Eine sozialtheoretische Perspektive. Zeitschrift für Soziologie 32 (4), 282–301. https://doi.org/10.1515/zfsoz-2003-0401.

Reid, L., Ellsworth-Krebs, K., 2019. Nudge(ography) and practice theories: Contemporary sites of behavioural science and post-structuralist approaches in geography? Progress in Human Geography 43 (2), 295–313. https://doi.org/10.1177/0309132517750773.

Rosa, H., 2013. Social Acceleration. A Theory of Modernity. Columbia University Press, New York.

Sattlegger, L., Rau, H., 2016. Carlessness in a car-centric world: A reconstructive approach to qualitative mobility biographies research. J. Transp. Geogr. 53, 22–31. https://doi.org/10.1016/j.jtrangeo.2016.04.003.

Schatzki, T., 2001. Introduction. In: Schatzki, T.R., Knorr-Cetina, K., von Savigny, E. (Eds.), Practice Turn in Contemporary Theory. Routledge, London/New York, pp. 10–23.

Schatzki, T., 2002. The site of the social: a philosophical account of the constitution of social life and change. University Park, Pennsylvania. Pennsylvania State University Press. Available online: www.jstor.org/stable/10.5325/j.ctt7v38n. [Accessed: 25 July 2021].

Scheiner, J., 2018. Why is there change in travel behaviour? In search of a theoretical framework for mobility biographies. Erdkunde 72 (1), 41–62. https://doi.org/10.3112/erdkunde.2018.01.03.

Scheiner, J., 2020. Changes in travel mode use over the life course with partner interactions in couple households. Transp. Res. Part A 132, 791–807. https://doi.org/10.1016/j.tra.2019.12.031.

Scheurer, J., 2001. Urban Ecology, Innovations in Housing Policy and the Future of Cities: Towards Sustainability in Neighbourhood Communities. PhD Thesis. Murdoch University Perth, Australia.

Schwanen, T., 2015. Beyond instrument: smartphone app and sustainable mobility. European Journal of Transport and Infrastructure Research 15 (4), 675–690. https://doi.org/10.18757/ejtir.2015.15.4.3104.

Selzer, S., 2021. Car-reduced neighborhoods as blueprints for the transition toward an environmentally friendly urban transport system? A comparison of narratives and mobility-related practices in two case studies. J. Transp. Geogr. 96, 103126 https://doi.org/10.1016/j.jtrangeo.2021.103126.

Selzer, S., Lanzendorf, M., 2019. On the road to sustainable urban and transport development in the automobile society? Traced narratives of car-reduced neighborhoods. Sustainability 2019 (11), 4375. https://doi.org/10.3390/su11164375.

Shove, E., 2010. Beyond the ABC: climate change policy and theories of social change. Environ. Planning Economy Space 42, 1273–1285. https://doi.org/10.1068/a42282.

Shove, E., 2017. Matters of practice. In: Hui, A., Schatzki, T., Shove, E. (Eds.), The Nexus of Practices. Connections, Constellations, Practitioners. Routledge, Abingdon/New York, pp. 155–168.

Shove, E., Pantzar, M., Watson, M., 2012. The Dynamics of Social Practice. Everyday Life and How It Changes. SAGE Publications Ltd, London.

Shove, E., Walker, G., 2010. Governing transitions in the sustainability of everyday life. Res. Policy 39, 471–476. https://doi.org/10.1016/j.respol.2010.01.019.

Sprei, F., Hult, C., Hult, Å., Roth, A., 2020. Review of the effects of developments with low parking requirements. Sustainability 12, 1744. https://doi.org/10.3390/su12051744.

Svennevik, E.M.C., Julsrud, T.E., Farstad, E., 2020. From novelty to normality: reproducing car-sharing practices in transitions to sustainable mobility. Sustainability: Science, Practice and Policy 16 (1), 169–183. https://doi.org/10.1080/15487733.2020.1799624.

Thomsen, J., Löfström, E., 2011. How to arrange for car-free living? Perspectives of future residents of a carbon-neutral housing area on non-motorized transport and car use (ECEEE 2011 Summer study - Energy efficiency first: The foundation of a low-carbon society. Panel 4: Transport and Mobility).

Urry, J., 2004. The 'System' of Automobility. Theory, Culture & Society 21 (4/5), 25–39. https://doi.org/10.1177/0263276404046059.

Villeneuve, D., 2017. Living without a car. A Canada-France comparison outlook, PhD Thesis, Ecole Polytechnique Fédérale de Lausanne, Lausanne.

Watson, M., 2012. How theories of practice can inform transition to a decarbonized transport system. J. Transp. Geogr. 24, 488–496. https://doi.org/10.1016/j.jtrangeo.2012.04.002.

Whitmarsh, L., O'Neill, S., Lorenzoni, I., 2011. Climate Change or Social Change? Debate within, amongst, and beyond Disciplines. Environment and Planning A. Economy and Space 43, 258–261. https://doi.org/10.1068/a43359.

Witzel, A., Reiter, H., 2012. The Problem-centered Interview. Principles and Practic. SAGE Publications, Los Angeles, London, New Delhi, Singapore, Washington DC.