

Article

Car Use of the Carless in Sweden: Everyday Life Conditions for Reducing Car Dependence

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Abstract: For the sake of reducing car dependence, much can be learned from non-car owners about how everyday life can, and cannot, be organized without private car ownership. This study aims to explore carless mobility, including the role of the car, in relation to specific everyday projects and life situations. We do so through a descriptive analysis of data from the Swedish National Travel Survey 2011–2016, comparing carless mobility with that of car owners. Theoretically, our analysis builds on a constraints perspective with respect to mobility, which is rooted in time geography. We find that the constraints associated with activities and life situations seem to matter for how mobility is performed and for the feasibility of living a carless life. Managing the material flows of the household (for example, buying food and disposing of waste) is a project handled differently by non-car owners, through using nearby services and with a low degree of car use. On the other hand, our data suggest that maintaining social relations is car dependent and can potentially be more problematic for the carless. Moreover, an individual's social network itself seems to be an important source of occasional car access. Results also indicate that the life situations of individuals may affect the mobility implications of carlessness, and the largest effect on trip frequency is found among carless retirees. From a planning perspective, and with the ambition to reduce private car use, this study identifies significant value in considering the different contexts of everyday life in which car use may or may not occur.

Keywords: car use; carless; non-car owners; everyday mobility; sustainable mobility; time geography; constraints



Citation: Lagrell, E.; Gil Solá, A. Car Use of the Carless in Sweden: Everyday Life Conditions for Reducing Car Dependence. *Sustainability* **2021**, *13*, 10250. <https://doi.org/10.3390/su131810250>

Academic Editor: Dimitris Potoglou

Received: 1 August 2021

Accepted: 3 September 2021

Published: 14 September 2021

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1. Introduction

Excessive car use strongly contributes to a series of societal problems. In addition to congestion and local air pollution, car traffic is a significant emitter of greenhouse gases, and Swedish authorities establish that in order to reach national targets on reducing climate impacts from the transport sector, a reduction in road traffic will be necessary [1]. Particularly in cities, reductions in car use also have the potential to promote well-being and the allocation of space for more sustainable purposes [2]. Furthermore, the prevalence of private car travel has socially excluding effects, circumscribing many non-car owners and enforcing expensive car ownership on others. Hence, in parallel with vehicle development and planning-oriented strategies, such as densification and development of transit services [3], a transition from ownership to access of transport means appears to be a necessary part of the solution to these problems.

Enabling such a transition calls for novel ways of thinking about mobility in relation to the context of everyday life, and much can be learned from those who presently do not own cars (here referred to as the carless) about how life can be organized without private car ownership. This paper takes an interest in the carless to gain insights into when non-car mobility is manageable, and the situations in which car access may remain necessary.

Carlessness and mobility have been extensively studied [4–8] (cf. Section 2.1), but mainly in terms of mobility in general and as related to the residential environment. Fewer

have considered how mobility is performed by the carless in relation to the constraints imposed by everyday activities and life situations. In an intensive study of mobility practices and accessibility strategies among voluntarily carless families with children in Gothenburg, Sweden [9], we saw that the conditions of carlessness are highly situated regarding the activities of everyday life. We found that mobility demands varied between activities: sometimes the use of nearby services and careful coordination were key, while for other activities, the car played a role, and the carless shared, rented, or borrowed a car, or relied on other peoples' car use [9]. These case-based results pose questions about carless mobility, including the role of the car, in relation to the everyday context of activities and varying life situations in the wider population. Probing these questions may give a fuller picture of the sufficiency of non-car mobility, as well as when car dependence renders the car necessary in everyday life.

In this study, we investigate the daily mobility of carless individuals in Sweden, and relate it to the contexts of everyday life by scrutinizing specific activities and life situations. Theoretically, the study builds on a constraints perspective on mobility, rooted in time-geography. In this perspective, which is further explained in Section 3 of the paper, mobility is seen in the context of the temporal and spatial constraints in which people and their everyday activities are embedded. Such constraints arise from life conditions and the geographic setting of the individual, but also from the spatial and temporal fixities of activities. Through this lens, we see the car use of carless individuals as a reflection of car dependence (i.e., an adjustment to mobility constraints).

Our purpose is to explore carless mobility patterns, including the occurrence of car use, in relation to different everyday life contexts. Such an investigation may uncover potentials for reducing car use as well as situations in which car access may remain necessary. Using data from the Swedish National Travel Survey 2011–2016, we scrutinize mobility in relation to (i) important everyday projects in the adult carless population, and (ii) three groups of carless expected to be subject to different sets of constraints due to their life situations: young adults, parents with children at home, and retirees. To better understand the mobility of the carless, we compare it with that of car owners. The following research questions guide our study:

1. In comparison with car owners, which are the mobility patterns of carless Swedes in relation to specific everyday projects and life situations?
2. In relation to these specific everyday projects and life situations, to what extent is the car used by the carless?

2. Theoretical Context

2.1. Previous Research on Carlessness and Everyday Mobility

The research field of carlessness and mobility is relatively small, mainly analysing dimensions such as trip frequency, trip distance, and travel time. As expected, the carless are generally less mobile than car owners [4–6]. In the UK, the carless in total made about 73% as many trips as did car owners, trips of the carless being on average 68% as long [6]. In the USA, the carless made 77% as many trips as did “low-owners” (i.e., <1 car per adult in the household) and 64% as many trips as did high-owners (i.e., 1+ cars per adult in the household) [5]. It is also found that car use is prevalent among the carless for 29% of trips in the U.S [5].

To investigate car use practices not based on private car ownership, Lovejoy [5] analysed US National Travel Survey data focusing on car use and mobility in different carless groups, and comparing with car owners. The results indicated that in denser residential environments, the carless' mobility was more similar to that of car owners. Furthermore, Lovejoy [5] found that the mobility implications of carlessness, as well as opportunities for car access, differed between different groups. While carless individuals in their 70s and 80s made 40% and 50%, respectively, of their trips in cars, they had the largest mobility deficit among the age groups. On the other hand, the 18–24-year-old age group, displaying a similar share of car use, had no mobility deficit compared with car

owners. Overall, carless women used cars more often and made more total trips than did carless men [5].

Car use and mobility among the carless has also been found to vary depending on the activity setting. Lovejoy [5] found car use among carless individuals to be the highest for religious activities and activities classed as social/recreational [5]. These results are in line with an interview study of voluntarily carless families in Gothenburg, Sweden [8], showing that some social activities give rise to car use. However, in the Gothenburg study, shopping activities seemed to be managed quite smoothly using other transportation modes and online services [9]. This is not the case in the US, where the carless was found to experience hardship in mobility related to shopping [5,10]. In a mixed-methods study of mobility practices among residents in car-free housing developments in Switzerland and Germany, Baehler [11] found car use to be very infrequent, less than once per month for most households. When car use did occur and was not for professional reasons, the most common reasons were shopping for big or heavy things, leisure, and visiting relatives and friends [12]. The literature demonstrates that the consequences of carlessness on trips for a given activity, such as shopping, can differ between geographical contexts.

In the carlessness and mobility research field, carlessness is often viewed in terms of two important and deeply interrelated aspects: the influence of the residential environment on the occurrence of carlessness (and the mobility implications thereof), and whether carlessness is voluntary or enforced. Analysing the British National Travel Survey for the years 2002–2010, Mattioli [6] found that the composition of carless people, as well as the mobility implications of carlessness, varied with residential environment. In more sparsely populated areas with less access to transit, carless individuals were more socially marginalized and the mobility gap was larger between the carless and car owners [6]. Similarly, King et al. [13] found carlessness to be less associated with poverty in the less car-oriented, pre-war-built New York district of Manhattan than in the rest of the USA. These results indicate that carless individuals residing in city centres are more often voluntarily carless than are rural residents. Developing this theme, Mitra and Saphores [7,8] used the California Household Travel Survey from 2012, which explicitly probed the cause of carlessness, to analyse the consequences of carlessness being voluntary or involuntary. They found that voluntarily carless individuals resided in denser, more varied and walkable areas with better access to transit than did the involuntarily carless. The same dataset was used by Brown [4], who also found that voluntary carlessness was associated with fewer mobility consequences in terms of trip distance and frequency than was carlessness enforced for economic, health, or driving ability reasons. Mitra and Saphores [8] have also established that the trips of involuntarily carless households take more time than those of voluntarily carless households, which is likely a further consequence of observed differences in the residential environment. From these findings we can establish that involuntary rather than voluntary carlessness increases mobility disadvantage, and that this is related to car dependence enforced by the built environment.

To sum up, we know a fair amount about the importance of the built environment, and about the association between social disadvantage and carlessness. However, our knowledge of the travel patterns of carless individuals in relation to the everyday life context is scantier, and this study contributes with such knowledge. It can help to identify possible enablers and barriers to reducing car dependence. Furthermore, as illustrated by this overview, much existing research into carlessness was conducted in an American context. The importance of the built environment and of the organization of society together call for attention to carless mobility in a wider range of geographic contexts. We answer this call by contributing insights from the Scandinavian setting of Sweden.

2.2. Conceptual Framework: Daily Mobility and Constraints

To analyse mobility in relation to the contexts of everyday life, we focus on the constraints that surround individuals and their activities. The notion of constraints stems from time-geographic thinking [14] and relates to the degrees of temporal and spatial fixity

of activities [15] as well as to individual conditions. Hägerstrand [14] organized constraints in three aggregate groups central to time-geography in its application to daily mobility. *Capacity constraints* are the cognitive and physical abilities of the individual, as well as the tools available to extend individual reach. Hence, apart from bodily capacity, access to mobility resources such as vehicles and, by extension, the economic means to acquire them are formative of capacity constraints. *Coupling constraints* concern the need to bring individuals and/or material objects together for the performance of activities. It may be the need for ingredients to prepare a meal, the dependent relationship between children and parents and the associated requirements for coordination, or the need to gather colleagues for a meeting at work. *Authority constraints* essentially arise from power relations [16] and comprise the rules, institutions, and norms controlling who may be in a certain place and when. Authority constraints may be explicit, such as the rules of traffic, office hours, or the opening hours of a convenience store; however, they may also arise from social norms and emotions, such as the notion of not “fitting in” somewhere or the fear of traversing certain places at night. Constraints are relational and stem from complex, multiple circumstances related, among others, to activities and life situations which are the foci of this paper.

2.2.1. Activities and Projects

In time-geographic thinking, mobility is understood in relation to the activities in which people engage [17] to realize their projects. Whether activities need to be performed in a given place at a given time—their degree of fixity in time and space—vary, affecting the conditions for mobility. Furthermore, some activities are mandatory while some are discretionary, which is a further aspect of their degree of fixity [18]. Projects, in turn, imply certain goals, aspirations, and intentions of various scopes [17]. In our study, we group common activities into central everyday projects: work or school, managing material flows, maintaining social relations, and leisure.

The activities within the *work or school* projects are often routinely and regularly performed. They are typically mandatory and associated with a high degree of fixity in both time and space, although flexibility is increasing in some types of professions through telework and flexible working hours [19,20], not least during the Covid19-pandemic. The routinized, high-priority character of many work and school activities makes them anchor-points in the organization of everyday life around which other, more flexible and discretionary activities may be arranged [21]. They are what Cullen and Godson [22], elaborating on Hägerstrand’s ideas, have called pegs: “Activities to which the individual is strongly committed and which are both space and time fixed tend to act as pegs around which the ordering of other activities is arranged and shuffled according to their flexibility ratings” [22] (p. 9). Hence, related mobility is prioritized to function smoothly and sometimes at the cost of other activities.

Project activities related to the household’s flows of material (i.e., the movement of things due to, for instance, the acquisition and disposal of consumer goods) can be described as routinized without being particularly fixed. Many such activities, as for instance shopping for groceries or disposing of used packaging for recycling, are much more flexible in time and space than are work or school activities. Material flow activities can therefore potentially be arranged around other projects, such as the anchor-points of work, school, and the home. However, trips related to managing material flows often include transporting objects that can be many, heavy, and/or bulky. This entails coupling constraints, but also renders capacity constraints stemming from physical abilities and access to various means of transport important for this project. Mattioli et al. [23] noted that such trips can be car dependent as the “cargo function of the car” may be hard to replace.

Earlier research indicates that car use increases with the flexibility of activities, and that activities unrelated to work, education, and household maintenance, during what may be called free time, can be assumed to be the most flexible [18]. In this paper, we deliberately distinguish between leisure activities and maintaining social relations, to explore any differences that could be ascribed to coupling constraints. The project that we

define as maintaining social relations includes activities whose main purpose is getting together with friends and family or escorting others. These activities are presumably much less routinized than are work, school, or material flow activities, and are more flexible than those pertaining to work or school. However, maintaining social relations requires adapting to the constraints, mobility resources, and preferences of others. Therefore, trips related to maintaining social relations can be a challenge for the carless [9], and may be handled through relying on the car-based mobility of others, adapting through borrowing or renting a car, or simply avoiding some of these activities. Leisure, entailing a great variety of activities, such as hobbies, visiting cafés, physical exercise, and cultural activities, can also be assumed to be much more flexible than work/school and material flow activities. Furthermore, leisure activities can be expected to be spatially more adjustable to anchor-points. For instance, a location for physical exercise, such as a gym, park, or training club, may be chosen in relation to the home or workplace. Still other aspects may affect the fixity of leisure activities, such as their degree of sociality or the influence of social norms and related expectations of mobility. These aspects can be prevalent, for instance, in relation to children's free-time activities [9].

2.2.2. Life Situations and Constraints

The fixity of activities, and related constraints, are not independent from the context in which the activities are performed [15]. An important aspect of this context is the individual's life situation. Though the life situation is undeniably unique for each individual, some aspects may be common on a group level and over the life cycle. In this study, we consider the constraints posed by the life situation by taking a closer look at the mobility of carless young adults, parents, and retirees. Being a parent typically entails coupling constraints due to the responsibility for one's children [24], and this is a life situation that has been associated with car use [25] and ownership [26]. Being a non-parent young adult, on the other hand, may imply fewer coupling constraints but more capacity constraints, in terms of economic resources, before one is established on the labor market. Furthermore, reductions over time in mobility patterns as well as car ownership and use among the young have been noted in several western countries [27–29]. Being a retiree entails few coupling constraints, but is more likely associated with capacity constraints in terms of economic resources and, with age, physical ability. The transition to retirement is in fact associated with changed mobility patterns [30], and car ownership has shown to be lower in retiree households [26]. Yet, retirees in Sweden travel more today than a few decades ago [31].

3. Materials and Methods

3.1. Databases and Geographic Selection

Our analysis is descriptive and based on the Swedish National Travel Survey, conducted annually during the years 2011–2016, with just over 64,000 respondents and 120,000 trips in total [32]. Since the carless share of the population is relatively small, we use pooled data for these years to increase robustness of the analysis. The data comprise detailed information about individuals (e.g., gender, age, car ownership, education, and employment) and households (e.g., income, children, and housing). It also includes information about the trips made on the day studied (for example, trip purpose, means of transportation, and distance). The data were collected via telephone interviews with individuals aged 6–84 years. The response rate declined over the years from 43 percent in 2011 to 32 percent in 2016. The main reason for non-response was that the respondents could not be reached during the interview period [33].

Except for the introductory review of the carless in Sweden, which included all types of municipalities (Section 3.3), our analysis refers to the adult population residing in non-rural Sweden, divided into urban and semi-urban municipalities (Figure 1). However, the “urban” designation should be seen as highly contextual, as Sweden is considerably more sparsely populated than most other European countries. We base our geographic

delimitation on the classification of the Swedish Association of Local Authorities and Regions [34] and exclude municipalities classed as small towns and rural municipalities. This selection excludes municipalities where a carless life is probably associated with isolation, for which the residential environment has been shown to be important [4,6], but without focusing solely on the major cities. According to the 2011–2016 survey, only 10 per cent of the Swedish carless population resided in the rural municipalities excluded from this study, while 20 per cent of the population as a whole lives in these municipalities.

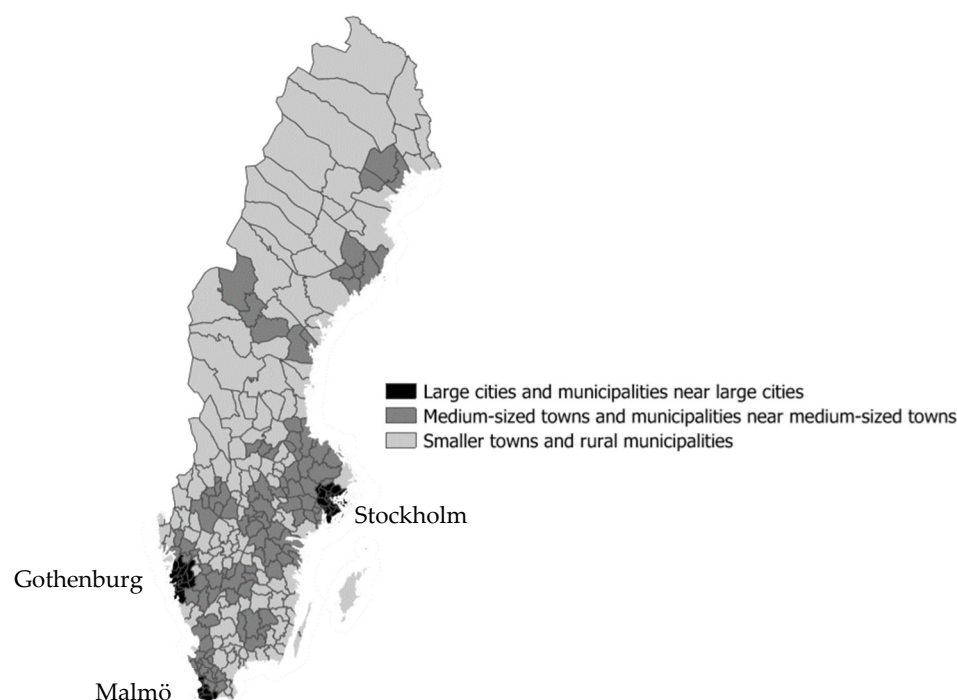


Figure 1. Classification of municipalities in Sweden based on population density and commuting patterns (revised from [34]). The category “Smaller towns and rural municipalities” is not included in the analysis. Geo data: Sweden Map, © Lantmäteriet.

3.2. Use of Variables

The basic unit of our analysis is trips made by members of non-car-owning households. Our research questions are answered through descriptive bivariate analyses, and through basic logistic regression analysis to support our findings (see Figure 2 for an illustration of the research procedure). The variables used to analyse mobility are *modal split* (i.e., walking, cycling, public transport, car, and other modes), *trip distance* (i.e., median kilometres), *trip chaining* (i.e., mean number of trip units per trip), and *trip frequency* (i.e., mean number of trips per person and day). The *share of car use* in the modal split, in combination with trip frequency as a measure of activity participation, is used as a proxy for car dependence. We also analyse how non-car owners gain access to cars, and their roles as drivers and passengers, indicating forms of non-private car use in relation to the constraints of everyday life.

The term *carless* refers to individuals who are part of households with no car in use. To contextualize the mobility of the carless, we compare it with that of car owners, defined as individuals who are part of households with one or more cars in use. Through this comparison, we expect to illuminate when the mobility patterns of the carless and car owners are consistent and whether they deviate in certain contexts. Such deviations can point to contexts in which the carless arrange the activities of everyday life to cope with their mobility resources. The contexts we refer to are: (1) everyday projects and (2) life situations, as illustrated in the theoretical section. In analysing everyday projects, we cluster trip purposes (i.e., activities) into four overarching projects (Table 1). Life situations are defined based on variables pertaining to individuals, representing various sets of

constraints (Table 1). The classifications of projects and life situations are based on our theoretical framework, previous research, and exploration of the dataset. The purpose of relating mobility to these contexts is to grasp the interplay of mobility and constraints, and the role of the car in everyday life.

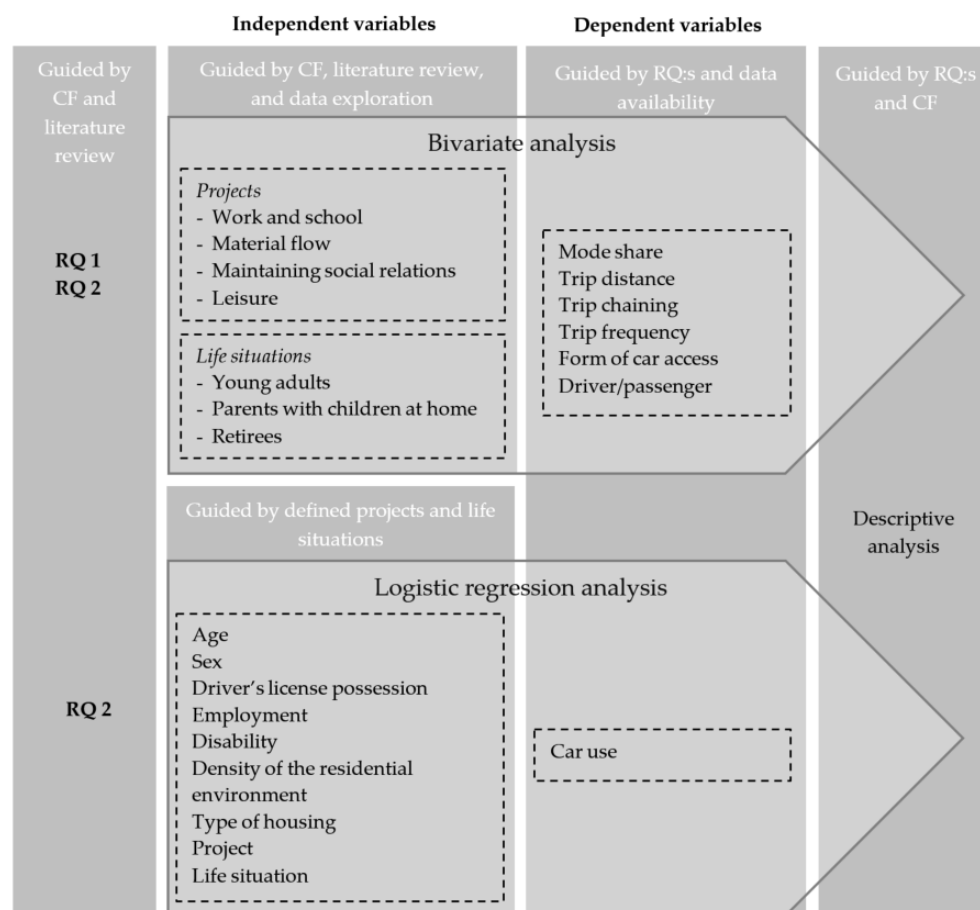


Figure 2. Research procedure. CF, Conceptual framework; RQ, Research question.

For the bivariate analyses, confidence intervals were calculated. Significant differences at 95%-level between carless and car-owners are marked in the tables. Significant differences between project and life situation groups are not marked in tables, however only significant differences are mentioned in the text if not explicitly indicated.

Finally, a logistic regression analysis serves to strengthen our findings. The dependent variable of this analysis is car trips (made by non-car owners), and we aim to explain which independent variables related to the individual, her environment, and everyday life projects exert significant influence in a joint analysis. As several independent variables are correlated (i.e., limit set to 0.3 in Pearson's correlation test), they are included in three separate models. In each model, only variables with no or very weak correlations are included. By using different models, we ensure that every independent variable is tested at least once. Since this is a logistic regression analysis, in order to describe the model fit we look at the Nagelkerke R^2 -value.

To refine the analysis, we exclude specific variables and values. Vacation trips are excluded from the analysis for two reasons. First, they are not interpreted as part of the everyday life context considered here. Second, they generate extreme values of the trip distance variable. Furthermore, the upper limit for the age interval of retirees was set to 80 years, as capacity constraints from physical disabilities are expected to increase with age, greatly affecting mobility and activity participation.

Table 1. Analyzed *everyday projects*, including defining activities and number of observed trips for carless and car owners. Analyzed *life groups*, including defining variables, number of individuals, and number of observed trips for carless and car owners.

Project		Defining Activities in the NTS		Number of Observed Trips	
				Carless	Car Owners
Work or school	Work	2528	16,685		
	School	593	960		
	Total	3121	17,645		
Material flow	Grocery shopping	1792	7891		
	Other purchases	974	5813		
	Fetching or delivering things	176	1289		
	Total	2942	14,993		
Maintaining social relations	Escorting/picking up another person	235	4900		
	Family and friends	1267	6114		
	Total	1502	11,014		
Leisure (vacations excluded)	Hobbies, music practice, study circles, courses	123	714		
	Restaurants and cafés	580	2110		
	Physical exercise: sports, walking, etc.	1590	9922		
	Entertainment, culture: parties, concerts, movies, etc.	462	1986		
	Club activities, religious practice	89	740		
	Other leisure activities	144	1088		
	Total	2988	16,560		
Group	Defining Variables in the NTS	Number of Individuals		Number of Observed Trips	
		Carless	Car Owners	Carless	Car Owners
Young adults	Aged 18–30 years	1512	1432	3905	4064
	No children				
	Not living with parents				
Parents with children at home	Aged > 18 years	710	8613	1706	26,987
	Parents Children aged 0–18 living at home				
Retirees	Aged 65–80 years	1528	6219	2252	13,477
	Not employed				

Source: RVU 2011–2016. Adult, non-rural population.

Some data shortcomings delimited the study. Although the non-weighted number of trips by carless individuals is sufficient for our analysis, the sample is too small for more complex scrutiny. An initial intention was to investigate the intersection between projects and life situations to answer questions regarding, for instance, how carless parents handle specific everyday projects. However, the data did not allow for such a fine-grained analysis. The complexity of such dimensions will require more in-depth methods. The data set the same limitation on our ability to thoroughly scrutinize the car trips made by non-car owners in relation to more detailed project categories.

3.3. Empirical Context: The Carless Swede

An overview of the socioeconomic and demographic composition of the carless population, and how this has changed over time, serves as a backdrop to our analysis. The overview is based on data from the 2011–2016 Swedish National Travel Survey, and change over time is analyzed through a comparison with the 1994–1999 survey. Currently, adults

in carless households represent 17 per cent of the adult Swedish population. Overall, several important aspects related to individuals and their environment are associated with carlessness. Being carless is more common among young adults, followed by individuals aged 65 years and older, than among the two middle-aged groups. There is a slight overrepresentation of carless individuals among women and the disabled, and a clear overrepresentation among the non-employed. Variables capturing individuals' resources in terms of income and driving license possession are clearly associated with carlessness. Also, the residential environment seems to be important at both the regional and local scales, as carlessness increases with population density at the municipal level, and is several times more common in apartment blocks than in single- or dual-family housing. The importance of the residential environment reflects the findings of previously cited studies in Europe [6] and the USA [4,7] showing that the more sparsely populated and farther from urban centres a residential environment is located, the more likely carlessness is to be associated with social exclusion. As for family composition, singles without children are the group with the largest share of carless individuals, followed by singles with children. Co-habitants, with or without children, are rarely carless.

Comparison of the carless population in the periods 1994–1999 and 2011–2016 offers insights into changes over time. As levels of car ownership increased in Sweden and globally over the period, the reasons for and consequences of carlessness can be expected to have shifted somewhat. From Table 2, we see that the importance of population density at the municipality level increased over time. Meanwhile, the role of gender, unemployment and low income slightly decreased. Most clearly, however, carlessness increased among young adults and decreased strongly among individuals aged 65 years and older.

This reflects a change in life situation in both groups, as found in previous research. Frändberg and Vilhelmson [35] discussed potentially important trends that may affect and postpone car use among young Swedes: longer education, delayed start of career and family formation, weaker economic conditions, and a greater tendency to settle in cities. Results from Norway also indicate that the decrease in driving license possession among young adults is particularly pronounced in urban environments [29]. Furthermore, the trend seen in the older segment of non-car owners reflects earlier research showing that car ownership has increased among older people in Sweden, Norway, and Denmark [31].

Table 2. Share of carless (%) in the adult population: different socioeconomic and demographic groups for the periods 1994–1999 and 2011–2016.

Variable and Class		1994–1999	2011–2016	Change Over Time (% Points)
Age, years	18–29	28.4	31.5	3.2 *
	30–49	13.8	12.5	–1.4
	50–64	11.7	11.4	–0.3
	65+	35.4	17.9	–17.5 *
Sex	Woman	25.1	19.2	–5.9 *
	Man	16.1	14.6	–1.5
Driver's license	Yes	12.0	11.5	–0.5
	No	57.0	53.5	–3.5 *
Gainfully employed	Yes	12.3	12.7	0.4
	No	33.5	24.5	–9.0 *
Disability **	Yes	-	21.4	-
	No	-	15.4	-

Table 2. Cont.

Variable and Class		1994–1999	2011–2016	Change Over Time (% Points)
Density in the residential environment (H-region) ***	Stockholm region	30.9	27.8	−3.1 *
	Malmö region	26.4	23.2	−3.2 *
	Gothenburg region	24.3	21.9	−2.4
	Medium-sized city regions	19.1	14.0	−5.1 *
	Small city regions	13.9	8.7	−5.2 *
	Small towns/rural regions	12.9	10.4	−2.5 *
	Remote rural regions	15.3	8.0	−7.3 *
Type of housing	Single or dual family	6.9	4.1	−2.8 *
	Apartment block	39.2	36.0	−3.2 *
Individual income (quartiles)	Low	32.8	29.2	−3.6 *
	Medium-low	20.9	14.8	−6.1 *
	Medium-high	13.2	10.9	−2.3
	High	7.7	7.7	0.0
Household income (quartiles) **	Low	-	41.0	-
	Medium-low	-	13.9	-
	Medium-high	-	5.6	-
	High	-	4.4	-
Family composition	Single with no children at home	51.7	44.2	−7.4 *
	Single with children at home	35.6	28.4	−7.1 *
	Cohabiting with partner and no children	10.5	8.5	−2.1 *
	Cohabiting with partner and children	6.1	5.2	−0.9
Entire population		20.7	16.9	−3.8 *
Number of observations		7084	6911	

Source: Riks RVU/RES 1994–1999 and RVU 2011–2016. Weighted values, adult population, all types of municipalities.* Statistically significant difference at $p < 0.05$. ** Data are missing for physical disabilities and household income in the 1994–1999 survey.*** Listed in order of declining density; density refers to population/km² [36].

Our overview shows that the Swedish carless population is diverse, although certain socioeconomic and demographic groups are overrepresented. Several aspects (related to the individual and her environment) influence car ownership, and their importance changes over time. In the next section, we analyse how these, and other aspects of everyday life, affect mobility patterns and car use.

4. Results

4.1. Introduction

To investigate the mobility patterns of carless individuals in relation to the everyday context of projects and life situations, we compare their trips with those of car owners. In doing so, our analysis first turns to mobility in relation to specific everyday life projects, and continues by focusing on mobility patterns in different life situations. We then analyse car use and means of gaining access to cars among the carless, in relation to the everyday contexts of projects and life situations.

4.2. Mobility and the Projects of Everyday Life

As shown in Table 3, carless individuals make shorter and fewer trips and do more trip chaining than car owners do. While shorter trips indicate reliance on nearby destinations, more trip chaining suggests a higher degree of multimodality and activity coordination. Walking and public transport are the most widely used modes, while cycling and driving each represent just over a tenth of the total trips. However, looking more closely at the projects of *work or school*, *managing material flows*, *maintaining social relations*, and *leisure*

brings further nuance to the pattern. We find that carless mobility, as well as the differences between carless individuals and car owners, varies between projects. For travelling to work or school, which is a relatively car-dependent project for car owners, public transportation predominates among the carless, mainly complemented by walking and cycling. This is the project in which the bicycle appears to play the most important role. The work/school trips are among the longest made by the carless, yet they are less than half as long as the equivalent trips made by car owners. For both groups, work/school is the project entailing the most trip chaining of all types of studied projects.

Table 3. Mobility and everyday projects of carless and car owners.

		All Individuals and Activities		Work or School		Material Flows		Social Relations		Leisure Activities	
		Carless	Car Owners	Carless	Car Owners	Carless	Car Owners	Carless	Car Owners	Carless	Car Owners
Mode (% of trips for the project)	Walking	40 *	19	23 *	9	52 *	17	30 *	11	58 *	44
	Bike	12 *	7	20 *	12	10 *	5	5	5	11 *	7
	Public transport	34 *	8	48 *	16	24 *	4	39 *	5	22 *	5
	Car	12 *	63	7 *	62	13 *	74	24 *	77	8 *	42
	Other modes	2 *	2	2 *	1	1 *	0	2	1	2	2
Trip distance (Km/trip, median)		3.0	5.0	4.0	9.0	1.0	3.5	4.0	6.0	2.5	4.0
Trip chaining (Number of trip units/trip, mean)		1.6 *	1.3	1.9 *	1.5	1.4 *	1.3	1.6 *	1.2	1.3 *	1.2
Trip frequency (Number of trips/day and person, mean)		2.0 *	2.6	0.6 *	0.7	0.4 *	0.5	0.2 *	0.4	0.5 *	0.6
Number of observed trips (unweighted)		12,588	73,799	3121	17,645	2942	14,993	1525	11,228	2988	16,560

Source: RVU 2011–2016. Trips made by adult, non-rural population. Weighted values. * Statistically significant difference at $p < 0.05$, comparing carless and car-owners.

Managing material flows of the household is the project for which the carless as well as car owners make the shortest trips, though that is not equally reflected in the car use of the two groups. For car owners, it is a highly car-dependent project, while for the carless, walking predominates. Also, the difference in trip frequency is small between carless and car owners for this project.

The most car-dependent project for both groups is maintaining social relations. Alongside work and school, maintaining social relations also entails the longest trips. Furthermore, maintaining social relations entails the largest differences between the carless and car owners in trip chaining and frequency.

Leisure is the project for which carless mobility is most similar to that of car owners in terms of trip distance, trip frequency, and trip chaining, and the level of car use is consistently low.

Whereas public transport plays an important role in accomplishing the anchor-point project of work or school, active modes (i.e., walking and biking) predominate for the more temporally flexible material flow and leisure projects. Maintaining social relations appears to be the most car dependent of the projects analysed here.

4.3. Mobility and Life Situations

Adding to the context of everyday life are the constraints imposed by life situation (Table 4). We identify three groups of carless individuals with differing sets of such constraints: *young adults*, *parents with children at home*, and *retirees*.

Table 4. Mobility and life situation of carless and car owners.

		All Individuals and Activities		Young Adults		Parents with Children at Home		Retirees	
		Carless	Car Owners	Carless	Car Owners	Carless	Car Owners	Carless	Car Owners
Mode (% of trips made by the group)	Walking	40 *	19	32 *	20	46 *	18	51 *	26
	Bike	12 *	7	15 *	7	11 *	8	10 *	5
	Public transport	34 *	8	35 *	10	30 *	7	27 *	5
	Car	12 *	63	16 *	60	10 *	66	11 *	64
	Other modes	2 *	2	3	3	2	1	2 *	1
Trip distance (Km/trip, median)		3.0	5.0	3.0	5.0	2.2	5.0	2.0	4.0
Trip chaining (Number of trip units/trip, mean)		1.6 *	1.3	1.7 *	1.3	1.6 *	1.3	1.4 *	1.2
Trip frequency (Number of trips/day and person, mean)		2.0 *	2.6	2.3 *	2.8	2.3 *	2.9	1.4 *	2.1
Number of observed trips (non-weighted)		12,588	73,799	3905	4064	1706	26,987	2252	13,477

Source: RVU 2011–2016. Trips made by adult, non-rural population. Weighted values. * Statistically significant difference at $p < 0.05$, comparing carless and car-owners.

Carless young adults are the group whose mobility in terms of trip distance and frequency differ the least from that of the corresponding car-owning group. Compared with the other carless groups, they have a more even modal split, travel farther, and do slightly more trip chaining.

Carless parents walk more and make considerably shorter trips than do car-owning parents. Furthermore, it is notable that the car-owning groups of parents and young adults have very similar patterns in all dimensions of mobility considered here, while among the carless, parents walk more and make shorter trips. As the age groups of young adults and parents overlap somewhat, this observation suggests that the responsibilities of parenthood affects the mobility patterns of carless parents.

Carless retirees are the group most often travelling on foot, doing so for half of their daily trips; they also make the shortest trips and do the least trip chaining. This pattern suggests that access to nearby services may be of great importance for carless retirees. Furthermore, the trip frequencies of this group are the lowest among the carless, and differ the most from those of the corresponding car-owning group.

In sum, our findings suggest that the mobility implications of carlessness may differ depending on life situation. Although carlessness affects mobility in all three groups, the trips made by young adults appear to be the least affected by carlessness, while the activity spaces of carless parents are quite strongly reduced in terms of trip distances. The largest carless effect on trip frequency is found among retirees.

4.4. Forms of Non-Ownership Car Use and Car Dependence in Everyday Life

We have thus far elaborated on carless mobility in relation to everyday life projects and life situations, and how it differs from, or resembles, that of car owners. We note that the car does play a role in the mobility of the carless, even though they do not own one—a seemingly paradoxical circumstance illustrating the role of the car in everyday life. We therefore take a closer look at how the carless acquire access to cars through forms of non-ownership car use (Tables 5 and 6). This description is followed by a regression analysis controlling for the aspects of everyday life correlated with car use among non-car owners—a proxy for car dependence in the everyday context.

Table 5. Shared car use and everyday projects, carless and car owners.

		All Individuals and Activities		Work or School		Material Flows		Maintaining Social Relations		Leisure Activities	
		Carless	Car Owners	Carless	Car Owners	Carless	Car Owners	Carless	Car Owners	Carless	Car Owners
Form of access (% of car trips)	Car owned by co-passenger	50 *	4	45 *	2	51 *	2	53 *	5	64 *	9
	Borrowed car	21 *	1	23 *	0	28 *	1	24 *	1	17 *	0
	Own car **	1 *	92	0 *	94	1 *	96	0 *	93	2 *	89
	Other access ***	28 *	4	32 *	4	21 *	1	23 *	1	16 *	2
Role (% of car trips)	Driver	39 *	83	47 *	93	42 *	81	40 *	79	29 *	73
	Passenger	61 *	17	53 *	7	58 *	19	60 *	21	71 *	27
Number of observed trips (non-weighted)		1591	46,820	225	11,167	369	10,897	387	8835	273	6871

Source: RVU 2011–2016. Trips made by adult, non-rural population. Weighted values. * Statistically significant difference at $p < 0.05$, comparing carless and car-owners. ** Own car refers to a car that is not borrowed or owned by a co-passenger, and does not fall within the definition of other access. *** Other access: Taxi transport for the disabled, taxi, rental car, employer's car, other car, unknown form of ownership.

Table 6. Shared car use and life situation, carless and car owners.

		All Individuals and Activities		Young Adults		Parents with Children		Retirees	
		Carless	Car Owners	Carless	Car Owners	Carless	Car Owners	Carless	Car Owners
Form of access (% of car trips)	Car owned by co-passenger	50 *	4	44 *	10	43 *	2	58 *	4
	Borrowed car	21 *	1	28 *	2	25 *	0	7 *	0
	Own car **	1 *	92	0 *	80	4 *	94	0 *	95
	Other access ***	28 *	4	28 *	7	27 *	3	35 *	1
Role (% of car trips)	Driver	39 *	83	48 *	78	45 *	86	13 *	75
	Passenger	61 *	17	52 *	22	55 *	14	87 *	25
Number of observed trips (non-weighted)		1591	46,820	600	2387	205	18,157	241	8410

Source: RVU 2011–2016. Trips made by adult, non-rural population. Weighted values. * Statistically significant difference at $p < 0.05$, comparing carless and car-owners. ** Own car refers to a car that is not borrowed or owned by a co-passenger, and does not fall within the definition of other access. *** Taxi transport for the disabled, taxi, rental car, employer's car, other car, and unknown form of ownership.

An overview of forms of car access reveals that half of the studied car trips are made in cars owned by fellow passengers. Adding the fact that six out of ten car trips are made as a passenger, this indicates that the carless quite often get rides from others. This is a tendency most pronounced for leisure activities and among retirees. Overall, one in five car trips undertaken by the carless are made in a borrowed vehicle, emphasizing the importance of social relations for car access, and this is most common for material flow activities. Depending on life situation, this reliance on social relations may inhibit independence in terms of mobility, particularly for retirees who drive on only about a tenth of their car trips.

To consolidate our interpretations regarding the role of the car in relation to different constraints, we conduct a logistic regression analysis aiming to explain in which everyday life contexts car trips are made by the carless. In doing so, we simultaneously consider all potentially influencing factors scrutinized above. The variables tested thus relate to constraints connected to the individual and her household, everyday projects and life situation, and physical environment.

In the regression analysis (Table 7), variables confirmed to be associated with a trip being made by car are holding a driving license, being gainfully employed, having a disability, making a trip for material flow purposes or to maintain social relations, and belonging to the young adult group. Aspects associated with less car use are increased age, living in an urban rather than a semi-urban municipality, living in an apartment building, making a trip for work or school, making a leisure trip, and belonging to the retiree group. The results of the regression are thus aligned with the above findings (Tables 3 and 4),

confirming the role played by different constraints. Taking a thorough look, we note that all independent variables related to everyday life projects have a significant effect on car use, underlining the importance of analysing carlessness in relation to the context of everyday life. However, the B-coefficients indicate only moderate differences between the four project variables, implying difficulties in singling out which of them interact the most with car use. Among the variables related to life situation, only two are significant (being a young adult or a retiree) and here too, the B-coefficients indicate only moderate differences between the variables. Interestingly, two variables are not significant in any of the three models: sex and belonging to the parent group. That sex is not significant is rather unexpected, since previous research has repeatedly found differences in car use between women and men [35,37–39]. In a corresponding regression analysis among car owners, however, gender displays a significant correlation, implying that gender structures are manifested differently among the carless as compared with car owners (cf. [5]). Overall, the analysis indicates that most of the tested independent variables are significantly associated with car use in the carless population. Yet, as the analysis uses trips, not individuals, as the observed unit, it might overestimate the significance of some of those relationships.

Table 7. The influence of socioeconomic conditions, project, and life situation on non-car owner's propensity to travel by car; logistic regression, dependent variable car trip (yes = 1).

Independent Variable		B-Coefficient					
		Model 1		Model 2		Model 3	
	Age (continuous)	−0.010	*	−		−	
	Sex (ref = woman)	−0.101		−0.092		−0.092	
	Drivers' license possession (ref. no)	0.394	*	0.329	*	0.389	*
	Gainfully employed (ref. no)			0.354	*		
	Having a disability (ref. no)			0.206	*		
	Density of the residential environment (ref. semi-urban)	−0.268	*	−0.289	*	−0.269	*
	Type of housing (ref. single/dual)	−0.624	*	−0.604	*	−0.589	*
Project (ref. other trips)	Work or school	−0.660	*				
	Material flows			0.292	*		
	Maintaining social relations	0.896	*	1.177	*	1.000	*
	Leisure activities					−0.294	*
Life situation (ref. other groups)	Young adults			0.410	*		
	Parents	−0.052		0.118		−0.088	
	Retirees					−0.318	*
	Number of observed trips	12,043		11,863		12,043	
	Nagelkerke R ²	0.065		0.062		0.055	
	Constant	−0.952	*	−2.029	*	−1.454	*

Source: RVU 2011–2016. Trips made by adult, non-rural population. Three models are used for the regression analysis due to correlation between several independent variables. Only variables with no or very weak correlations are included in each model (cf. Section 3.2) * $p < 0.05$.

5. Discussion

The results presented above indicate some notable differences in the mobility patterns of carless and car owning persons. In this section, we discuss our findings in the light of previous research and the conceptual framework. As might be expected we see that, overall, carless individuals make fewer and shorter trips and do more trip chaining than car owners. This is in line with earlier research establishing that the carless are less mobile than car owners [5,6,8]. However, this pattern is not consistently reflected in all

everyday life contexts. Our findings illustrate that constraints associated with different projects and life situations are part of shaping carless mobility, and for the feasibility of a carless life. The limits to carless mobility can be discerned from car dependence in specific situations, inhibiting activity participation or inducing car use, while seeming to function more smoothly in other contexts. The car may be necessary for some trips, to manage the varying fixity of activities in time and space, and to fulfil the need to coordinate with people and things involved in activities. However, in many situations, multimodality and non-car mobility [40], prioritizing proximity [9,41], and coordinating activities may in fact be sufficient.

Long distances and a high degree of trip chaining characterize work and school trips for both carless individuals and car owners. However, for the carless, work/school trips are much shorter but still more chained than for car owners, aligned with a large share of public transport in the modal split of the carless. This pattern suggests that the carless, to a larger extent than car owners, must adapt their choices of residency, work, and school (the “pegs” of everyday life [22]) to the available mobility resources. The opposite strategy would be adapting mobility to the choices of residency and employment, as may be the case in a more car-reliant lifestyle. While this may limit the options of the carless for employment, education, and housing, trip frequencies indicate that travelling to work and school is often possible without private car use. Obviously, this can be at the cost of other projects.

The results further indicate that walking and cycling are common modes in managing material flows and leisure, two projects for which activities are likely to be more flexible as to when and where they can be performed. For these projects, trip frequencies for the carless are close to those of car owners. The results thus suggest that such activities may be feasible through mobility based on proximity to everyday life pegs [22]. While leisure activities are only weakly car dependent for car owners as well, the pattern is different in managing material flows, for which the gap between carless and car owners is wider in terms of distance and modal split. Previous research has shown that “the cargo function” of the car makes shopping and waste-disposal activities car dependent [23]; our results nevertheless indicate that the carless somehow manage to fulfil the material flow project. This could partly be ascribed to the residential environment, as non-car ownership is more common in denser areas. Nevertheless, whether the carless handle activities pertaining to material flows differently than do car owners merits more in-depth attention. Arguably, the concept of consumption may be understood otherwise without constant access to a private car, as the need to plan, coordinate, and prioritize is more pressing.

Maintaining social relations is the most car-dependent project for both the carless and car owners. Possible difficulties are discerned for the carless regarding this project as they make fewer trips for social relations purposes, which can be interpreted as an inhibiting effect of carlessness. Social activities inherently entail adjusting to the localization and mobility practices of others (for instance, when visiting relatives in a car-dependent residential area [9]). Car dependence in getting together with friends and family is thus attributed to coupling constraints in combination with the uncertainty that may arise from the temporal and spatial flexibility of the involved activities [9]. However, difficulties derived from carlessness can to some extent be handled using various strategies. Sometimes, borrowing a car or getting a ride will help overcome the constraints on getting together with family and friends. Indeed, the relatively high degree of car use by the carless to maintain social relations suggests that for them, fulfilling this project can itself be dependent on mobility resources in the social network [10]. Furthermore, what our data do not reveal is the strategy observed elsewhere [9] of relying on the car-based mobility of others, for example, being visited by friends and family instead of visiting them. The carless could also be thought of as *delegating* car ownership to others, or as using cars more collectively as a form of *carpooling*. Finally, comparison of the projects maintaining social relations and leisure shows that leisure activities are less car dependent for both car owners and non-car owners, and less inhibited in terms of activity participation (i.e., trip frequency) for the carless.

This suggests that activities specifically pertaining to maintaining social relations make a considerable contribution to the part of leisure time previously shown to entail heavy car use [42]. It may be that leisure activities are easier to fit into everyday sequences of routine activities, such as work or school, or that leisure activities are themselves more routinized than are activities in the project of maintaining social relations. Instead, innovative shared mobility solutions may be of increasing importance in maintaining social relations. Such solutions can complement public transport systems, increasing flexibility and allowing the users of buses, trains and trams to reach beyond the boundedness of major transportation networks [43].

We also see that constraints related to life situation matter for carless mobility. Traveling on foot and by public transport to nearby destinations characterizes carless parents' mobility patterns. The smaller activity space this entails may well constitute an active approach to coping with the coupling constraints of parenthood. However, depending on the residential environment, limited reach can also mean fewer opportunities in everyday life. Furthermore, while car-owning young adults and parents have quite similar mobility patterns, the relationship is different among the carless. Carless young adults have a much more even modal split than do the other carless groups and have a larger share of car use, leaving their trip distance and trip frequency somewhat less affected by carlessness. This pattern of young adults may partly be an effect of the absence of constraints imposed by parenthood and old age. However, it may also reflect a generational shift that has been noted elsewhere, with young people obtaining a driver's license and acquiring a car later in life [29]. This postponement may give them time to learn how to arrange their daily activities using other modes. The somewhat larger degree of car use among carless young adults than among the other carless groups may be explained by better opportunities to borrow vehicles, for instance, from their parents, but could also signal stronger tendencies among young adults to decouple car use and ownership. Carless retirees have a similar modal split to that of carless parents, and they also make short trips. However, the great difference in trip frequencies between carless and car owning retirees indicate that some desired activities may not come about for the carless retirees. This unfulfilled demand would likely be due to capacity constraints related to their life situation, i.e., poorer health and financial conditions obstructing suitable mobility solutions.

In sum, our results show that the contexts of projects and life situations does matter for the mobility implications of carlessness, pointing towards the significant value of considering the everyday context that may or may not prompt car use.

6. Conclusions

Reducing private car use is a prerequisite for more sustainable transport systems and enhanced well-being in cities. To increase knowledge about the everyday conditions for such reductions, this study investigates the mobility patterns of carless individuals and their car use in relation to central everyday life projects and life situations, and compare them to that of car owners. We find tendencies regarding when carless mobility may be feasible, as well as when the demands for fast and flexible mobility are higher. From these findings, we draw some conclusions with relevance for sustainability policy and planning, aiming to facilitate car-free mobility. Notably, accessing important amenities smoothly in everyday life can be seen as central to individuals' wellbeing, and thus to socially sustainable planning [44]. These results should therefore be seen as relevant when aiming for both environmentally and socially sustainable cities.

A first conclusion is that several activity contexts seem to be managed differently by the carless, compared with car owners. One such example is the project of managing material flows, for which the carless are apparently not overwhelmingly constrained, but have found other ways of managing. Potentially, managing material flows is a "low-hanging fruit" in the endeavor to reduce car dependence. It may be facilitated by online services, shared transport solutions, and the proximity-oriented localization of amenities. Maintaining social relations, on the other hand, is a project for which policy and planning

efforts may not be sufficient to reduce car dependence. Getting together with family and friends may be harder to manage without car-based mobility due to the need to coordinate with others in flexible and unpredictable ways. Inclusive solutions for shared mobility may have an important role to play for these activities.

Another conclusion from the study is that the potential for car-free mobility differ depending on the life situation. For many carless retirees, access to nearby opportunities may be crucial for activity participation. Carless parents also rely heavily on proximity and a high degree of walking, while the mobility patterns of young adults are somewhat less affected.

The quantitative character of our study entails limitations, suggesting avenues for future research. Importantly, we find that carlessness and car use are not mutually exclusive phenomena. Especially among young adults, there may be other ways of using the car than those involving private ownership. Thus, in-depth investigations of the car use of non-car-owning young adults could bring knowledge of what such car use, and associated mobility strategies, may be like.

Furthermore, investigations of specific project contexts could offer valuable information regarding how constraints can be handled in less car-dependent ways, such as those found in relation to the project of material flow management. In such studies, intensive research methodology involving interviews and detailed time diaries would enable a deeper contextualization of mobility in relation to individual constraints and the fixity of activities. A qualitative approach could also grasp the implications of ongoing digitization for carless mobility strategies. Also, and in accordance with findings in the USA [5], we see an indication that among the carless, car use is not affected by gender to the same extent as among car owners. This suggests that gender and gender structures play different roles in carless than in car-owning households [45], a difference that should be further investigated.

Finally, our results do not constitute a universal narrative, and the focus on non-rural Sweden has important implications for our findings. The geographic setting and built environment, the way infrastructure has developed, and the norms inherent to society all affect how constraints arise within different groups. Similar studies in other geographic and social settings where, for instance, car use is associated with congestion and long travel times, would likely reveal different insights.

Author Contributions: Conceptualization, E.L.; data curation, E.L.; formal analysis, E.L. and A.G.S.; funding acquisition, A.G.S.; writing-original draft preparation, E.L. and A.G.S.; writing-review and editing, E.L. and A.G.S. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by a faculty grant for Ph.D. research, with additional funding from the Swedish Energy Agency (grant number 2018-006519).

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Acknowledgments: The authors would like to thank the Mobility Research Group at the University of Gothenburg, and particularly professor Eva Thulin and Senior Researcher Bertil Vilhelmson, for constructive comments on an early draft of this paper.

Conflicts of Interest: The authors declare no conflict of interest.

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